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AUGUST, 1912

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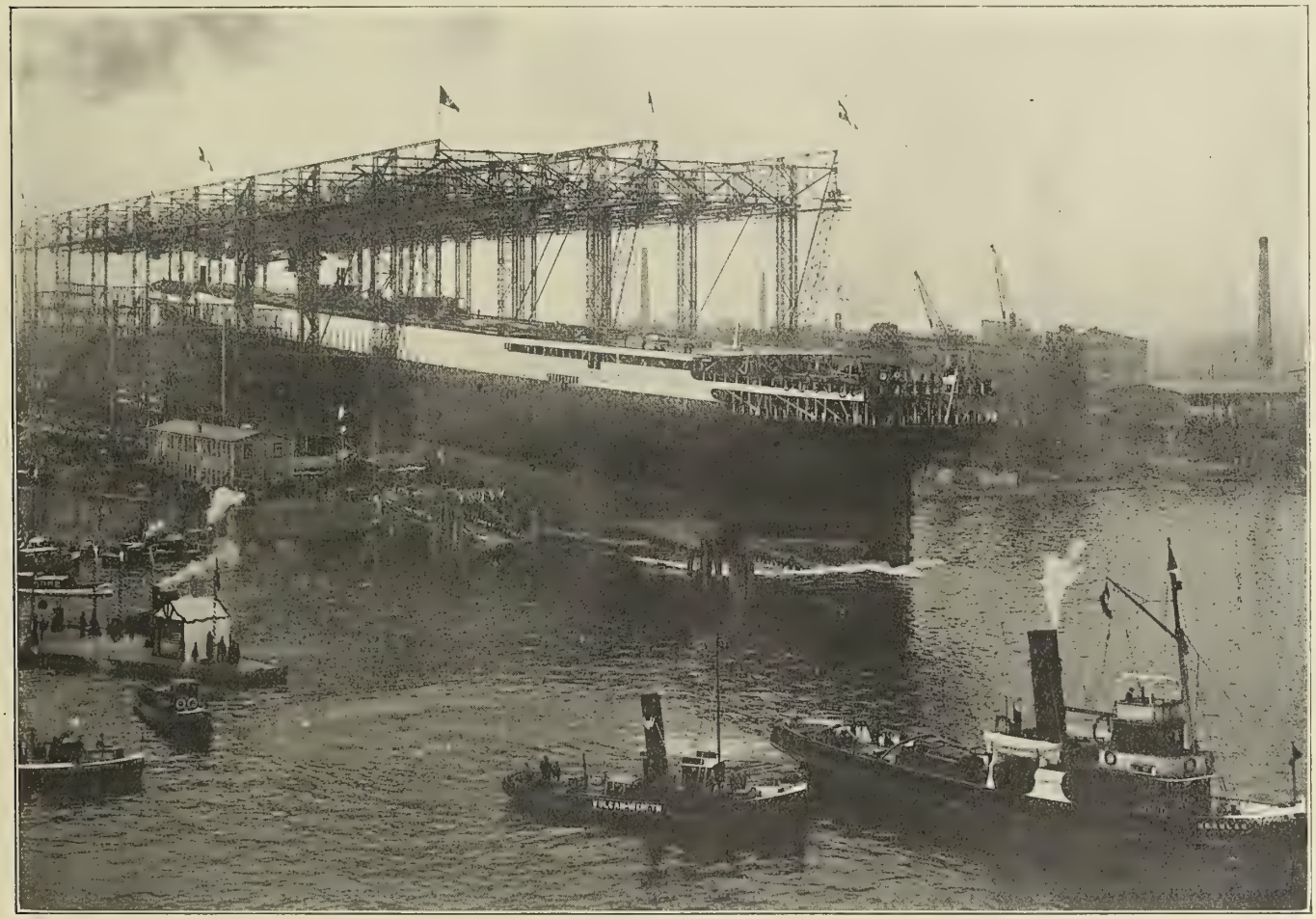
The Hamburg-American Company's New 50,000-Ton Liner

Although the construction of the Hamburg-American liner *Imperator* was begun at the Vulcan Shipbuilding Works, Hamburg, over two years ago, very little information was made public at that time regarding the details of this magnificent steamship. She was known as the biggest ship then projected, and the natural inference has been that she would be designed to provide every modern device for safety, comfort and luxury, as has been the aim in the company's previous vessels. At the time of the launching of the vessel in May last, when she was christened by the Kaiser, many of the important details regarding the construction and equipment of the vessel were made known, and we are indebted to the owners for the following particulars:



LAUNCH OF THE IMPERATOR

The length of the vessel is 900 feet, the beam 96 feet and the depth 62 feet. The boat deck is 100 feet from the keel, and the trucks of the masts rise to a height of 246 feet above the keel. Three funnels are installed, each 69 feet long of oval shape, measuring 29 feet by 18 feet.

The hull is fitted with a cellular double bottom extending for nearly the whole length of the vessel. The dimensions of the tank itself are 767 feet 6 inches length, 85 feet width, 6 feet depth, giving a cubic capacity of 291,000 gallons. The hull is divided into watertight compartments by both transverse and longitudinal bulkheads. There are twelve transverse bulkheads, those amidships extending from the double bottom to a height of 50 feet, or for a distance well above the waterline. Towards the bow, the bulkheads run up to a greater height, and the forward collision bulkhead extends to the first deck. Longitudinal bulkheads are fitted in the boiler space to form wing bunkers, and also in the forward engine room, where the wing compartments are used for auxiliaries. In the after engine room there is a single longitudinal bulkhead on the center line of the ship, the cargo holds, both forward and aft, of course, extending across the full width of the ship. In the bulkheads there are in all thirty-six watertight doors, which are fitted with an automatic closing system

operated by the use of electric and pneumatic power, enabling complete control of all the doors from the navigating bridge, or the doors may be controlled individually at their separate locations.

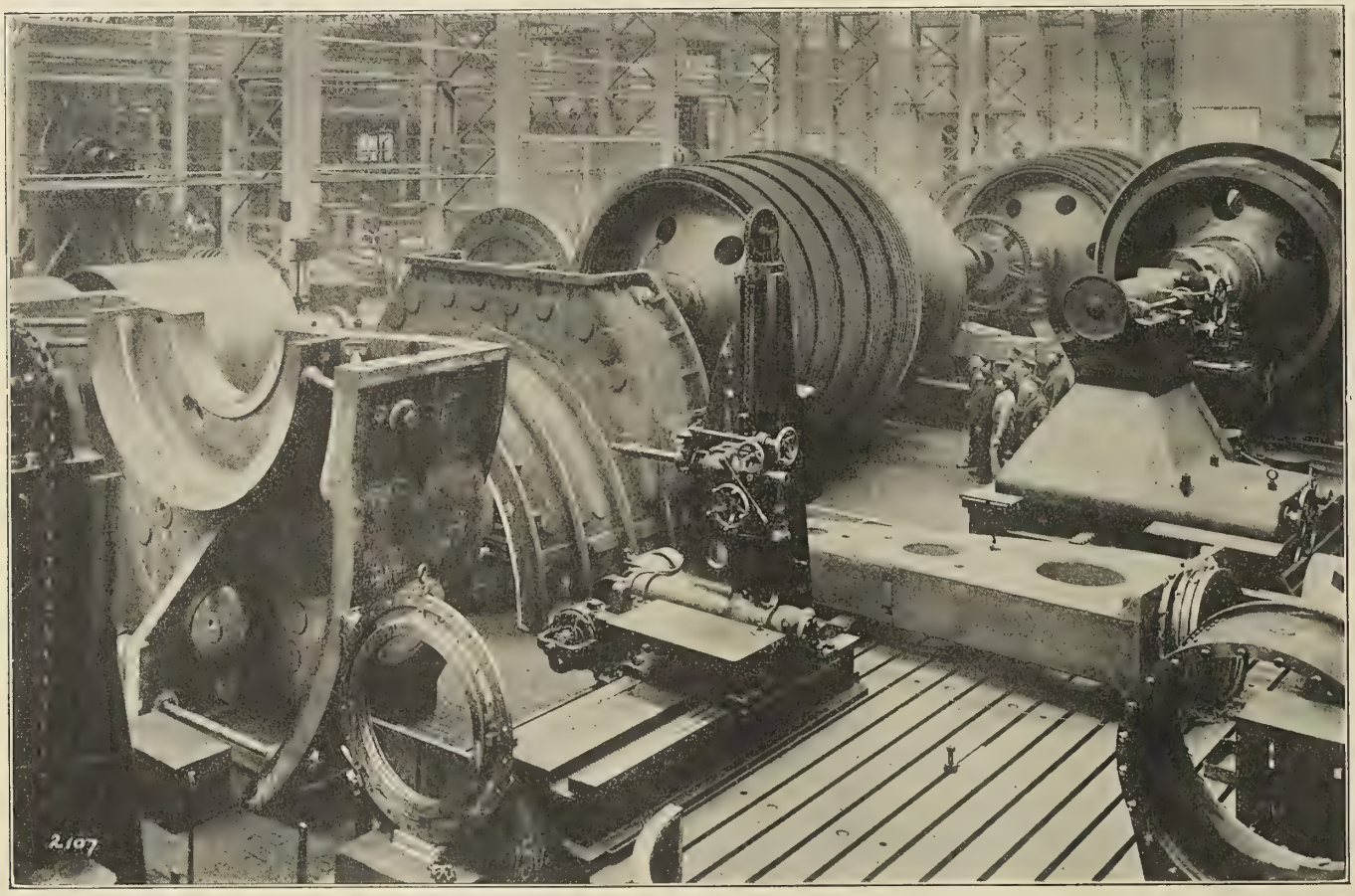
Only a general statement has as yet been made regarding the machinery arrangement of the vessel. The main engines are Parsons turbines of 70,000 horsepower, operating four propellers, which are designed to give the ship a speed of 22½ knots. The propeller shafts are 18 inches diameter, with four-bladed propellers of Turbadium bronze, 16 feet 5 inches diameter. Some idea of the size of the turbines can be gained from the illustrations and from the fact that the low-pressure rotors weigh 135 tons. The outer casing inclosing these rotors is 25 feet long and 18 feet wide.

The arrangement of passenger accommodations in the *Imperator* are in keeping with the modern tendency to eliminate the cramped quarters which were formerly found on shipboard. The size of staterooms and of public saloons has been increased. In the first class staterooms the old-time built-in berths have been replaced by metal bedsteads, and a large number of single-berth rooms have been provided. Similar arrangements have been made in the second class accommodations, and the whole arrangement will very strongly resemble the accommodations to be found in first class hotels on shore. All the rooms will be provided with electric connections for lighting, heating, ventilation, call bells, etc. Supplementary to the steam heating system electric heaters will be provided, and a complete artificial ventilating system is installed which provides for excellent air circulation according to the requirements of each room. Besides the large main stairways between decks, electric elevators provide communication through five decks. The Ritz-Carlton and Veranda café features, which were brought out on the Hamburg-American steamers *America* and *Kaiserin Auguste Victoria*, will be found on the *Imperator*. Besides this there will be a ball room for concerts, entertainments, dances, etc., a very complete gymnasium and small shops to meet the needs of the passengers.

A large amount of deck space in first-cabin quarters is set aside for promenade decks. The upper promenade deck is inclosed at the front and along two-thirds of the length on each side by heavy plate-glass windows for protection in stormy weather.

Anti-rolling tanks, built according to the Frahm system, are installed to reduce the rolling of the ship. Lifeboats and liferafts will be provided sufficient to accommodate all on board. A gyroscopic compass will be used, and the ship will be fitted with submarine signals and a powerful wireless outfit.

Electric current for lights and power purposes on board the ship are provided by five turbo-generators of 2,000 amperes and 110 volts. An additional generator of 100 amperes capacity is placed above the waterline to provide current for lighting in case the main electric plant is disabled by flooding of the dynamo compartment. It is expected that all minor repairs will be carried out on board the ship, for which purpose a completely fitted machine shop has been located in the forward engine room, the equipment consisting of lathes, drills, planers and a full equipment of small tools.



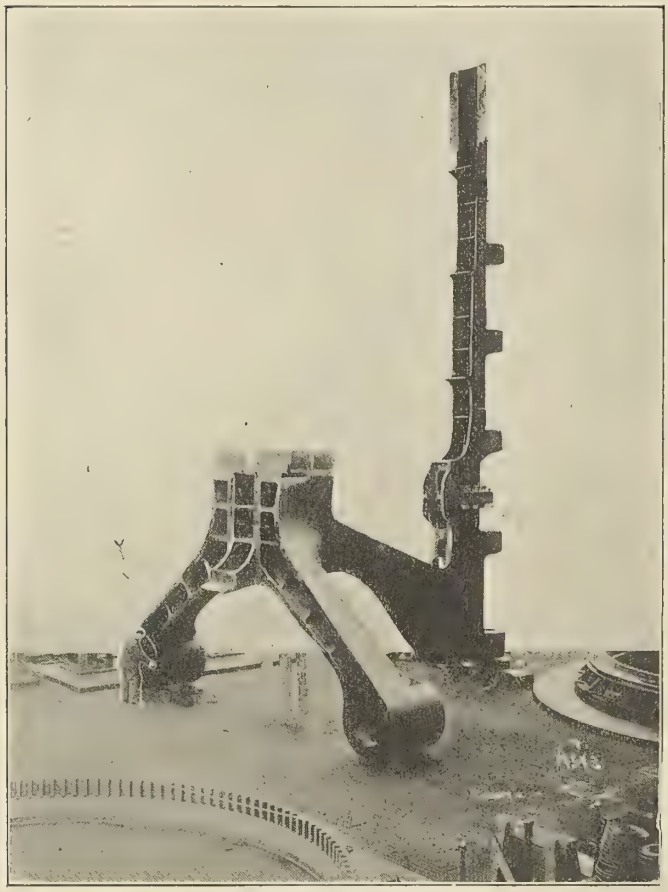
IMPERATOR'S TURBINES UNDER CONSTRUCTION IN THE VULCAN SHOPS

The steam fire-fighting apparatus is of the latest and most approved type. In addition, hand extinguishers are conveniently placed throughout the ship. Powerful pumps will always be ready for immediate use. As a special protection against fire a number of smoke bulkheads have been constructed in the passenger decks.

Not only will every practical mechanical device be installed, but every possible facility for their use by the crew has been

THE IMPERATOR AS THE VESSEL WILL APPEAR WHEN COMPLETED

provided for. Station bells, locating the number and position of each man on board, from the captain down to the last trimmer, no matter what the occasion or stress, will assemble the crew into a completely organized force, able to control any situation. Frequent drills will enable familiarity and breed confidence in this most valuable human factor. Fire and boat drills will be held frequently. At night, and during fog, all watertight doors will be closed. The living quarters of the officers and crew are so arranged and placed that each



RUDDER POST OF THE IMPERATOR

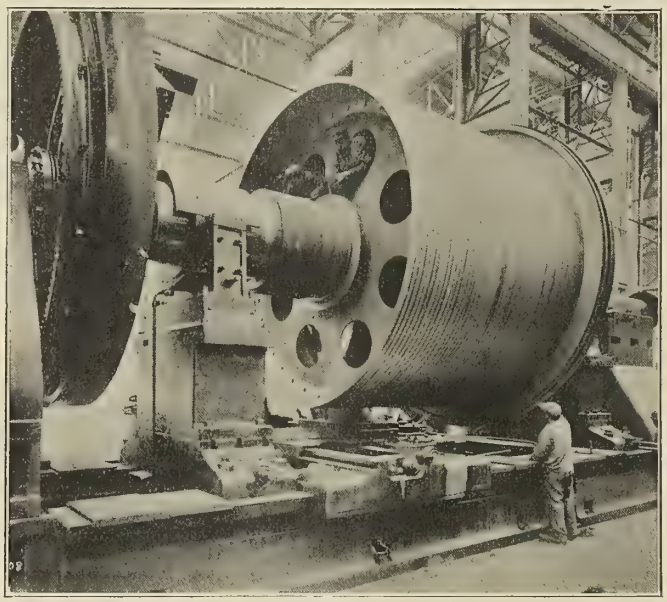
man will be near to his work, so that even in off-duty periods prompt response to all calls can be made.

The question has been raised whether the development of such gigantic structures is justified by the needs of the world's commercial requirements and not merely to justify their projector's desire to excel and to have an advantage over competitors. Certain it is that the safety of ocean travel is not diminished by the construction of ships of large dimensions, but, on the contrary, it is greatly increased. Professor Pagel, of the Germanic Lloyd, states that safety of travel at sea increases with the size of the ships. He demonstrates in detail why the stability and reserve buoyancy of the large ship exceed those of the smaller vessel. The ability of the large ship to withstand the effects of sea and wind is well known. The extreme steadiness of the large ship, even in a rough sea, has been looked upon as a boon by those passengers susceptible to seasickness. But the most vital consideration in reference to construction, materials and methods of insuring safety, as laid down by the highest authorities, such as the Germanic Lloyd's, the immigration authorities and other bodies, is as thoroughly and conscientiously applied in the large vessel as in her small sisters, with the additional advantage that in the larger vessel these measures for safety can be carried out in a stronger and even more satisfactory way.

Relation of Units Horsepower and Kilowatt*

There was, before 1911, no precise definition of the horsepower that was generally accepted and authoritative, and different equivalents of this unit in watts are given by various books. The most frequently used equivalent in watts, both in the United States and England, has been the round number, 746 watts, and in 1911 the American Institute of Electrical Engineers adopted this as the exact value of the horsepower. It is obviously desirable that a unit of power should not vary from place to place, and the horsepower thus defined as a fixed number of watts does indeed represent the same rate of work at all places. Inasmuch as the "pound" weight, as a unit of force, varies in values as g, the acceleration of gravity, varies, the number of foot-pounds per second in a horsepower accordingly varies with the latitude and altitude. It is equal to 550 foot-pounds per second at 50 degrees latitude and sea level, approximately the location of London, where the original experiments were made by James Watt to determine the magnitude of the horsepower.

The "Continental horsepower," which is used on the continent of Europe, differs from the English and American horsepower by more than 1 percent, its usual equivalent in watts being 736. This difference is historically due to the confusion existing in weights and measures about a hundred years ago. After the metric system had come into use in Europe the various values of the horsepower in terms of local feet and pounds were reduced to metric units, and were rounded off to 75 kilogram-meters per second, although the original English value was equivalent to 76.041 kilogram-meters per second. Since a unit of power should represent the same rate of work at all places, the "Continental horse-



ONE OF THE IMPERATOR'S LOW-PRESSURE ROTORS

power" is best defined as 736 watts; this is equivalent to 75 kilogram-meters per second at latitude 52 degrees 30 minutes, or Berlin. The circular gives tables showing the variations with latitude and altitude of the number of foot-pounds per second and of kilogram-meters per second in the two different horsepowers.

These values, 746 and 736 watts, were adopted as early as 1873 by a committee of the British Association for the Advancement of Science. The value, 0.746 kilowatt, will be used in future publications of the Bureau of Standards as the exact equivalent of the English and American horsepower.

*Abstract of Circular of the Bureau of Standards No. 34, Washington, D. C., June 1, 1912.

It is recognized, however, that modern engineering practice is constantly tending away from the horsepower and toward the kilowatt. The Bureau of Standards of the Department of Commerce and Labor and the Standards Committee of the American Institute of Electrical Engineers recommend the kilowatt for use generally instead of the horsepower as the unit of power.

Marine Engineering Development

Probably never before in the history of engineering have so many and diverse proposals been engaging the serious study of experts for increasing efficiency and economy in marine engineering, and that the problem of ship propulsion is on the eve of great devolpments seems certain. In the recently-issued International Number of *The Shipbuilder* some of the greatest living British and foreign experts have been expressing their views, and these are briefly summarized below.

Dr. Rudolf Diesel, the eminent German scientist and engineer, whose name will always be associated with the internal-combustion engine, writes: "With regard to marine engines, it is unquestionable that one of the greatest evolutions of modern industry will be connected with the development of the Diesel oil engine, and Great Britain, as the greatest shipping nation of the world, will derive the greatest advantage from it."

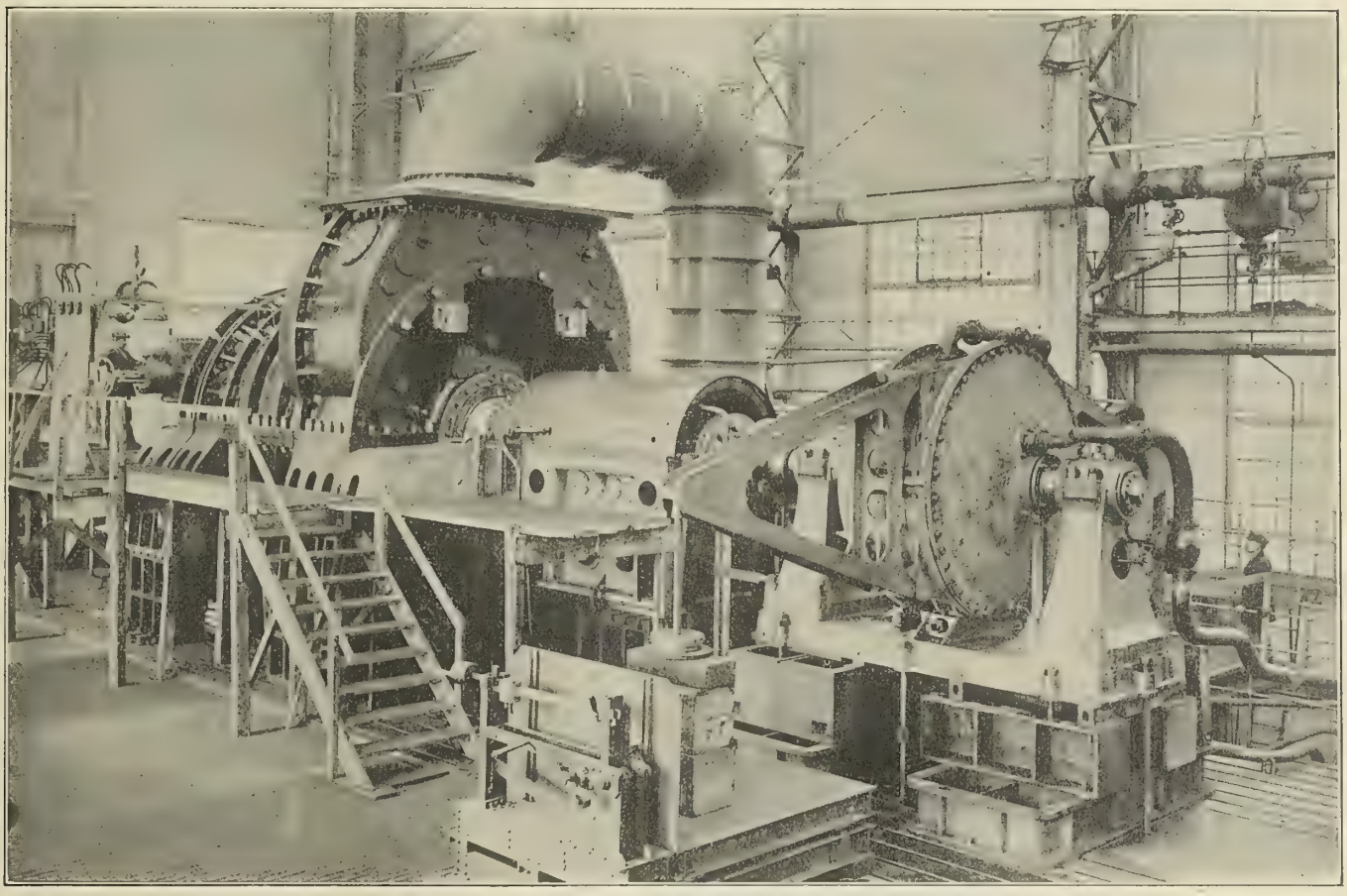
Mr. D. M. Shannon, a well-known British expert, looks still further than his German contemporary, and remarks: "Oil-engine workers recognize that the piston engine is only a temporary solution of the problem of internal-combustion engines, and that a reversion to the turbine principle will be the natural outcome of the inherent limitations and disadvantages of the reciprocating form of motor."

Advocating another form of internal-combustion engine, Mr. A. C. Holzapfel, who has devoted much labor and money to the solution of the problem, writes: "The suction gas engine and plant in their present form are capable of vast improvement as regards marine work, but the possibilities of this type of prime mover are such as to deserve the careful consideration of all marine engineers."

Mr. E. Hall-Brown, the president of the Institution of Engineers and Shipbuilders in Scotland, has great faith in the marine steam engine, for he writes: "The author is a firm believer in the future of the internal-combustion engine, both on sea and land. He is not, however, convinced that the final development will be along the present lines. As regards reliability, ease in adjustment and simplicity in manipulation, the marine steam engine is yet without a rival. If to these advantages be added increased economy, such as he believes possible of attainment, it is doubtful if any internal-combustion engine yet proposed will take its place in ordinary merchant vessels."

Sir Charles A. Parsons, the inventor of the marine steam turbine bearing his name, advocates the claims of the geared turbine, remarking: "Apart from the adoption of superheated steam or the burning of oil fuel in the boilers from which further advantages would be secured, the author estimates that the saving of 15 percent in coal consumption, which can be effected by the adoption of geared turbines instead of reciprocating engines, means, in the case of a cargo steamer carrying 8,500 tons deadweight and steaming 10½ knots on service, a gain to the shipowner in the neighborhood of $9,740 (£2,000) per annum."

Finally, Mr. Harold E. Yarrow, the brilliant young Clyde shipbuilder and engineer, draws attention to the improvement in economy of from 8 to 10 percent when using 100 degrees F. of superheat, and from 11 to 13 percent when using 150 degrees F. of superheat.



TESTING ONE OF THE IMPERATOR'S TURBINES AT THE BUILDER'S WORKS

Liquid Fuel Measurement on Oil-Burning Steamships—I

BY HOWARD C. TOWLE

The rapidly increasing use of liquid fuel in naval, merchant and pleasure vessels calls attention to the possibility of the owner and the engineer knowing, with considerable accuracy, the fuel consumption of such vessels, without the trouble and errors that persistently appear in ordinary service measurements of fuel economy in coal-burning power installations. The difficulty of obtaining accurate results, and the expense for the necessary additional labor and superintendence in the fireroom, when making coal-burnings tests, are such that the majority of owners are of necessity contented with figures for fuel economy deduced from more or less exact guesses made by the engineer at the amount of coal consumed and the power developed. It is unfortunately true that these approximations are made in many cases with prejudice, since it is realized that the total consumption that is reported must

FIG. 1

be in reasonable agreement with the amount of coal purchased to avoid an unpleasant interview with the manager.

These difficulties are easily avoided in a vessel using liquid fuel, for after a liquid fuel tank is once carefully measured and the capacity properly calculated and recorded for future use, the only requirement for obtaining a reliable record of the fuel consumption is reasonable accuracy on the part of the vessel's engineers in making the necessary measurements. These measurements should include the depth or ullage of the fuel in the tanks, and specific gravity and the temperature of the fuel, and in some vessels the draft of the vessel forward and aft, and the list of the vessel to starboard or port.

Since the measurement of the depth of the fuel in the tanks and the recording of the corresponding capacity must be made many times during the life of the vessel, it is evident that these operations should be made as simple and as free from chance of error as is consistent with accurate results. This should be done, even though the work involved in the first measurement of the capacity and in the preparation of capacity scales or diagrams is considerably increased to obtain that result, since this work is required but once.

There are two methods of measuring the depth of liquid in a tank in common use at present, namely, the sounding rod, used for measuring the distance from the surface of the liquid to the bottom of the tank, and the ullage stick or rod, used in measuring the distance from the surface of the liquid to the top of the tank.

The sounding rod as it is ordinarily used, while sufficiently accurate for the measurement of water ballast or other liquids of which only the approximate quantity is wanted, has several serious faults which render it unsuitable for the accurate measurement of liquid fuel. The most common trouble is the fact that sediment, dirt or other foreign substances may accumulate at the bottom of the sounding-tube and make the readings inaccurate and variable from time to time. A similar trouble, but one which applies to the construction of the capacity scales and not to the operation on board the vessel, is the difficulty of making a correct allowance for the depth or thickness of any cement used under the end of the sounding pipe. In the better class of work, however, cement is never used in the oil tanks.

Although the varieties of sounding rods are legion, perhaps the most common type is made from flat iron about ⅛ inch by ⅝ inch, with joints at short intervals, by means of which it may be folded so as to be easily stowed away in a small space. These joints also make the rod sufficiently flexible to pass around bends which are unfortunately sometimes placed in sounding pipes. As sounding pipes are usually made from 1½-inch standard pipe, it is always possible, and indeed probable, that careless use of the small, short section sounding

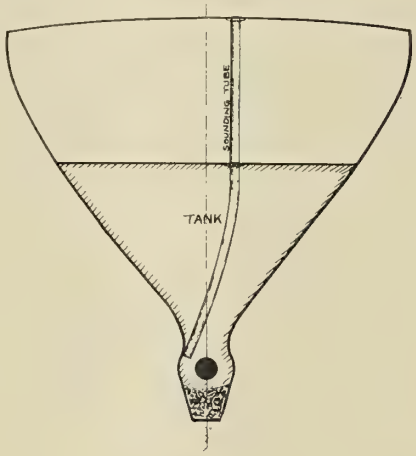


FIG. 2

rod will indicate a greater depth of liquid than actually exists, because the excessive clearance between the rod and the pipe allows the rod to shorten up under its own weight. This will be clearly seen by reference to Fig. 1, which shows the lower end of the sounding rod which has come in contact with the bottom of the tank.

Another fault, already suggested in the last paragraph, and which is of more common occurrence than it should be, is to place bends in the sounding pipe in order to clear obstructions that prevent a direct lead to the deepest part of the tank. It is evident that the difference in direction of the part above and the part below the bend will produce a difference in the rate of vertical travel of the rod as it is lowered into the sounding pipe, which will result in soundings exceeding the true vertical depth of the liquid. In approximate scales for capacity this change of rate could be allowed for, but for the best and most accurate work it is better to have all pipes straight.

Fig. 2 shows another source of error, this particular case occurring on a recently completed Government vessel. The rod here lands against the sloping side of the vessel and will seldom stop its downward course at the same point. Evidently the designer considered it more important to indicate the presence of the last drop of liquid than to have the soundings accurate.

It may be objected that these sources of error are of no great influence in the total capacity, and such indeed might

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON
1.0000	10.0	8.3373	268.67	62.367	35.916
.9995	10.1	8.3331	268.80	62.336	35.935
.9990	10.1	8.3289	268.94	62.305	35.952
.9985	10.2	8.3247	269.08	62.273	35.970
.9980	10.3	8.3206	269.22	62.242	35.988
.9975	10.4	8.3164	269.35	62.211	36.006
.9970	10.4	8.3122	269.48	62.180	36.025
.9965	10.5	8.3081	269.62	62.149	36.043
.9960	10.6	8.3039	269.75	62.118	36.061
.9955	10.6	8.2997	269.89	62.086	36.079
.9950	10.7	8.2956	270.02	62.055	36.097
.9945	10.8	8.2914	270.16	62.024	36.115
.9940	10.9	8.2872	270.29	61.993	36.134
.9935	10.9	8.2831	270.43	61.962	36.151
.9930	11.0	8.2789	270.57	61.930	36.170
.9925	11.1	8.2747	270.70	61.899	36.188
.9920	11.1	8.2706	270.84	61.868	36.206
.9915	11.2	8.2664	270.98	61.837	36.224
.9910	11.3	8.2622	271.12	61.806	36.243
.9905	11.4	8.2581	271.26	61.775	36.261
.9900	11.4	8.2539	271.39	61.743	36.279

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON.
.9900	11.4	8.2539	271.39	61.743	36.279
.9895	11.5	8.2497	271.52	61.712	36.298
.9890	11.6	8.2455	271.67	61.681	36.316
.9885	11.6	8.2414	271.80	61.650	36.334
.9880	11.7	8.2372	271.94	61.619	36.353
.9875	11.8	8.2330	272.17	61.587	36.372
.9870	11.9	8.2289	272.21	61.556	36.390
.9865	11.9	8.2247	272.35	61.525	36.408
.9860	12.0	8.2205	272.49	61.494	36.426
.9855	12.1	8.2164	272.63	61.463	36.445
.9850	12.1	8.2122	272.77	61.431	36.463
.9845	12.2	8.2080	272.90	61.400	36.482
.9840	12.3	8.2039	273.04	61.369	36.500
.9835	12.4	8.1997	273.18	61.338	36.518
.9830	12.4	8.1955	273.32	61.307	36.538
.9825	12.5	8.1914	273.46	61.276	36.556
.9820	12.6	8.1872	273.60	61.244	36.575
.9815	12.6	8.1830	273.74	61.213	36.593
.9810	12.7	8.1788	273.88	61.182	36.612
.9805	12.8	8.1747	274.02	61.151	36.631
.9800	12.9	8.1705	274.16	61.120	36.649

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON
.9600	15.9	8.0038	279.87	59.872	37.413
.9595	16.0	7.9996	280.01	59.841	37.432
.9590	16.1	7.9954	280.16	59.810	37.452
.9585	16.1	7.9913	280.31	59.779	37.472
.9580	16.2	7.9871	280.45	59.748	37.491
.9575	16.3	7.9829	280.60	59.716	37.511
.9570	16.3	7.9788	280.75	59.685	37.530
.9565	16.4	7.9746	280.90	59.654	37.550
.9560	16.5	7.9704	281.04	59.623	37.569
.9555	16.6	7.9662	281.18	59.592	37.589
.9550	16.7	7.9621	281.33	59.560	37.609
.9545	16.7	7.9579	281.48	59.529	37.628
.9540	16.8	7.9537	281.62	59.498	37.648
.9535	16.9	7.9496	281.78	59.467	37.668
.9530	17.0	7.9454	281.92	59.436	37.688
.9525	17.1	7.9412	282.07	59.405	37.708
.9520	17.1	7.9371	282.22	59.373	37.727
.9515	17.2	7.9329	282.37	59.342	37.747
.9510	17.3	7.9287	282.52	59.311	37.767
.9505	17.4	7.9246	282.67	59.280	37.787
.9500	17.4	7.9204	282.81	59.249	37.807

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON.
.9500	17.4	7.9204	282.81	59.249	37.807
.9495	17.5	7.9162	282.96	59.217	37.827
.9490	17.6	7.9121	283.11	59.186	37.847
.9485	17.7	7.9079	283.26	59.155	37.867
.9480	17.8	7.9037	283.41	59.124	37.887
.9475	17.9	7.8995	283.56	59.093	37.906
.9470	17.9	7.8954	283.71	59.062	37.926
.9465	18.0	7.8912	283.86	59.030	37.947
.9460	18.1	7.8870	284.01	58.999	37.967
.9455	18.2	7.8829	284.16	58.968	37.987
.9450	18.2	7.8787	284.31	58.937	38.007
.9445	18.3	7.8745	284.46	58.906	38.027
.9440	18.4	7.8704	284.61	58.874	38.047
.9435	18.4	7.8662	284.76	58.843	38.067
.9430	18.5	7.8620	284.92	58.812	38.087
.9425	18.6	7.8579	285.06	58.781	38.108
.9420	18.7	7.8537	285.22	58.750	38.128
.9415	18.8	7.8495	285.37	58.719	38.148
.9410	18.9	7.8454	285.52	58.687	38.168
.9405	18.9	7.8412	285.67	58.656	38.189
.9400	19.0	7.8370	285.82	58.625	38.209

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON
.9800	12.9	8.1705	274.16	61.120	36.649
.9795	12.9	8.1663	274.30	61.088	36.668
.9790	13.0	8.1622	274.44	61.057	36.687
.9785	13.1	8.1580	274.58	61.026	36.706
.9780	13.2	8.1538	274.72	60.995	36.724
.9775	13.2	8.1497	274.86	60.964	36.743
.9770	13.3	8.1455	275.00	60.933	36.762
.9765	13.4	8.1413	275.14	60.901	36.781
.9760	13.4	8.1372	275.28	60.870	36.800
.9755	13.5	8.1330	275.42	60.839	36.818
.9750	13.6	8.1288	275.56	60.808	36.837
.9745	13.7	8.1247	275.70	60.777	36.856
.9740	13.7	8.1205	275.85	60.745	36.875
.9735	13.8	8.1163	275.99	60.714	36.894
.9730	13.9	8.1121	276.13	60.683	36.914
.9725	13.9	8.1080	276.27	60.652	36.932
.9720	14.0	8.1038	276.41	60.621	36.951
.9715	14.1	8.0996	276.56	60.590	36.970
.9710	14.2	8.0955	276.70	60.558	36.989
.9705	14.2	8.0913	276.84	60.527	37.008
.9700	14.3	8.0871	276.98	60.496	37.027

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON.
.9700	14.3	8.0871	276.98	60.496	37.027
.9695	14.4	8.0830	277.13	60.465	37.046
.9690	14.5	8.0788	277.27	60.434	37.065
.9685	14.5	8.0746	277.41	60.402	37.085
.9680	14.6	8.0705	277.56	60.371	37.104
.9675	14.7	8.0663	277.70	60.340	37.123
.9670	14.8	8.0621	277.84	60.309	37.142
.9665	14.9	8.0580	277.99	60.278	37.161
.9660	15.0	8.0538	278.13	60.247	37.181
.9655	15.0	8.0496	278.27	60.215	37.200
.9650	15.1	8.0455	278.42	60.184	37.219
.9645	15.2	8.0413	278.56	60.153	37.238
.9640	15.3	8.0371	278.71	60.122	37.258
.9635	15.3	8.0329	278.85	60.091	37.277
.9630	15.4	8.0288	279.00	60.059	37.296
.9625	15.5	8.0246	279.14	60.028	37.316
.9620	15.6	8.0204	279.29	59.997	37.335
.9615	15.6	8.0163	279.43	59.966	37.355
.9610	15.7	8.0121	279.58	59.935	37.374
.9605	15.8	8.0079	279.72	59.904	37.393
.9600	15.9	8.0038	279.87	59.872	37.413

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLONS	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON
.9400	19.0	7.8370	285.82	58.625	38.209
.9395	19.1	7.8329	285.98	58.594	38.229
.9390	19.2	7.8287	286.13	58.563	38.250
.9385	19.2	7.8245	286.28	58.531	38.270
.9380	19.3	7.8203	286.43	58.500	38.290
.9375	19.4	7.8162	286.59	58.469	38.311
.9370	19.5	7.8120	286.74	58.438	38.331
.9365	19.6	7.8078	286.89	58.407	38.352
.9360	19.6	7.8037	287.04	58.376	38.372
.9355	19.7	7.7995	287.20	58.344	38.393
.9350	19.8	7.7953	287.35	58.313	38.413
.9345	19.9	7.7912	287.51	58.282	38.434
.9340	20.0	7.7870	287.66	58.251	38.454
.9335	20.1	7.7828	287.81	58.220	38.475
.9330	20.2	7.7787	287.97	58.188	38.496
.9325	20.2	7.7745	288.12	58.157	38.516
.9320	20.3	7.7703	288.28	58.126	38.537
.9315	20.4	7.7662	288.43	58.095	38.558
.9310	20.5	7.7620	288.59	58.064	38.578
.9305	20.6	7.7578	288.74	58.032	38.599
9300	20.7	7.7536	288.90	58.001	38.620

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S. GALLON	U.S. GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON
.9300	20.7	7.7536	288.90	58.001	38.620
.9295	20.8	7.7495	289.05	57.970	38.641
.9290	20.8	7.7453	289.21	57.938	38.661
.9285	20.9	7.7411	289.36	57.908	38.682
.9280	21.0	7.7370	289.52	57.877	38.703
.9275	21.1	7.7328	289.68	57.845	38.724
.9270	21.2	7.7286	289.83	57.814	38.745
.9265	21.2	7.7245	289.99	57.783	38.766
.9260	21.3	7.7203	290.14	57.752	38.787
.9255	21.4	7.7161	290.30	57.721	38.808
.9250	21.5	7.7120	290.46	57.689	38.829
.9245	21.6	7.7078	290.61	57.658	38.850
.9240	21.7	7.7036	290.77	57.627	38.871
.9235	21.8	7.6994	290.93	57.596	38.892
.9230	21.9	7.6953	291.09	57.565	38.913
.9225	21.9	7.6911	291.25	57.534	38.934
.9220	22.0	7.6869	291.40	57.502	38.955
.9215	22.1	7.6828	291.56	57.471	38.976
.9210	22.2	7.6786	291.72	57.440	38.997
.9205	22.3	7.6744	291.88	57.409	39.018
.9200	22.4	7.6703	292.04	57.378	39.040

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S.GALLON	U.S.GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON
.9200	22·4	7.6703	292.04	57.378	39.040
.9195	22·5	7.6661	292.20	57.346	39.061
.9190	22.5	7.6619	292.35	57.315	39.082
.9185	22·6	7.6578	292.51	57.284	39.103
.9180	22·7	7.6536	292.67	57.253	39.125
.9175	22·8	7.6494	292.83	57.222	39.146
.9170	22·9	7.6453	292.99	57.191	39.167
.9165	23·0	7.6411	293.15	57.159	39.189
.9160	23·1	7.6369	293.31	57.128	39.210
.9155	23·1	7.6328	293.47	57.097	39.232
.9150	23·2	7.6286	293.63	57.066	39.253
.9145	23·3	7.6244	293.79	57.035	39.274
.9140	23·4	7.6203	293.95	57.003	39.296
.9135	23·5	7.6161	294.11	58.972	39.317
.9130	23·6	7.6119	294.28	56.941	39.339
.9125	23·7	7.6077	294.44	56.910	39.360
.9120	23·7	7.6036	294.60	56.879	39.382
.9115	23·8	7.5994	294.76	56.848	39.404
.9110	23·9	7.5952	294.92	56.816	39.425
.9105	24·0	7.5911	295.08	56.785	39.447
.9100	24·1	7.5869	295.25	56.754	39.469

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S.GALLON	U.S.GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON.
.9100	24·1	7.5869	295.25	56.754	39.469
.9095	24·2	7.5827	295.41	56.723	39.490
.9090	24·3	7.5786	295.57	56.692	39.512
.9085	24·3	7.5744	295.73	56.660	39.534
.9080	24·4	7.5702	295.90	56.629	39.556
.9075	24·5	7.5661	296.06	56.598	39.577
.9070	24·6	7.5619	296.22	56.567	39.599
.9065	24·7	7.5577	296.38	56.536	39.621
.9060	24·7	7.5536	296.55	56.505	39.643
.9055	24·8	7.5494	296.71	56.473	39.665
.9050	24·9	7.5452	296.88	56.442	39.687
.9045	25·0	7.5410	297.04	56.411	39.709
.9040	25·1	7.5369	297.21	56.380	39.731
.9035	25·2	7.5327	297.37	56.349	39.753
.9030	25·3	7.5285	297.53	56.317	39.775
.9025	25·4	7.5244	297.70	56.286	39.797
.9020	25·4	7.5202	297.86	56.255	39.819
.9015	25·5	7.5160	298.03	56.224	39.841
.9010	25·6	7.5119	298.19	56.193	39.863
.9005	25·7	7.5077	298.36	56.161	39.885
.9000	25·8	7.5035	298.53	56.130	39.907

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S.GALLON	U.S.GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON
.8800	29.2	7.3368	305.31	54.883	40.814
.8795	29.3	7.3326	305.48	54.852	40.837
.8790	29.4	7.3284	305.66	54.821	40.861
.8785	29.5	7.3243	305.83	54.789	40.884
.8780	29.6	7.3201	306.01	54.758	40.907
.8775	29.7	7.3159	306.18	54.727	40.930
.8770	29.7	7.3118	306.36	54.696	40.954
.8765	29.8	7.3076	306.53	54.665	40.977
.8760	29.9	7.3034	306.71	54.633	41.001
.8755	30.0	7.2993	306.88	54.602	41.024
.8750	30·1	7.2951	307.06	54.571	41.047
.8745	30.2	7.2909	307.23	54.540	41.071
.8740	30.3	7.2868	307.41	54.509	41.094
.8735	30.3	7.2826	307.58	54.478	41.118
.8730	30.4	7.2784	307.76	54.446	41.141
.8725	30.5	7.2743	307.94	54.415	41.165
.8720	30.6	7.2701	308.11	54.384	41.189
.8715	30.7	7.2659	308.29	54.353	41.212
.8710	30.8	7.2617	308.47	54.322	41.236
.8705	30.9	7.2576	308.64	54.290	41.260
.8700	31·0	7.2534	308.82	54.259	41.283

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S.GALLON	U.S.GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON
.8700	31·0	7.2534	308.82	54.259	41.283
.8695	31·1	7.2492	309.00	54.228	41.307
.8690	31·2	7.2451	309.18	54.197	41.331
.8685	31·3	7.2409	309.35	54.166	41.355
.8680	31·4	7.2367	309.53	54.135	41.378
.8675	31·5	7.2326	309.71	54.103	41.402
.8670	31·6	7.2284	309.89	54.072	41.426
.8665	31·7	7.2242	310.07	54.041	41.450
.8660	31·8	7.2201	310.25	54.010	41.474
.8655	31·9	7.2159	310.43	53.979	41.498
.8650	32·0	7.2117	310.61	53.947	41.522
.8645	32·1	7.2076	310.78	53.916	41.546
.8640	32·2	7.2034	310.97	53.885	41.570
.8635	32·3	7.1992	311.14	53.854	41.594
.8630	32·4	7.1951	311.33	53.823	41.618
.8625	32·5	7.1909	311.51	53.792	41.642
.8620	32·5	7.1867	311.69	53.760	41.666
.8615	32·6	7.1825	311.87	53.729	41.691
.8610	32·7	7.1784	312.05	53.698	41.715
.8605	32·8	7.1742	312.23	53.667	41.739
.8600	32·9	7.1700	312.41	53.636	41.763

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S.GALLON	U.S.GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON
.9000	25·8	7.5035	298.53	56.130	39.907
.8995	25·9	7.4994	298.69	56.099	39.929
.8990	26.0	7.4952	298.86	56.068	39.952
.8985	26·0	7.4910	299.02	56.037	39.974
.8980	26·1	7.4869	299.19	56.006	39.996
.8975	26·2	7.4827	299.36	55.974	40.018
.8970	26·3	7.4785	299.53	55.943	40.041
.8965	26·4	7.4743	299.69	55.912	40.063
.8960	26·5	7.4702	299.86	55.881	40.085
.8955	26·6	7.4660	300.03	55.850	40.108
.8950	26·6	7.4618	300.19	55.818	40.130
.8945	26·7	7.4577	300.36	55.787	40.153
.8940	26·8	7.4535	300.53	55.756	40.175
.8935	26·9	7.4493	300.70	55.725	40.197
.8930	27·0	7.4452	300.87	55.694	40.220
.8925	27·1	7.4410	301.03	55.663	40.242
.8920	27·2	7.4368	301.20	55.631	40.265
.8915	27.2	7.4327	301.37	55.600	40.288
.8910	27·3	7.4285	301.54	55.569	40.310
.8905	27·4	7.4243	301.71	55.538	40.333
.8900	27·5	7.4202	301.88	55.507	40.336

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S.GALLON	U.S.GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON.
.8900	27·5	7.4202	301.88	55.507	40.336
.8895	27·6	7.4160	302.05	55.475	40.378
.8890	27·7	7.4118	302.22	55.444	40.401
.8885	27·8	7.4077	302.39	55.413	40.424
.8880	27·8	7.4035	302.56	55.382	40.446
.8875	27·9	7.3993	302.73	55.351	40.469
.8870	28·0	7.3951	302.90	55.320	40.492
.8865	28·1	7.3910	303.07	55.288	40.515
.8860	28·2	7.3868	303.24	55.257	40.538
.8855	28·3	7.3826	303.41	55.226	40.561
.8850	28·4	7.3785	303.59	55.195	40.584
.8845	28·4	7.3743	303.76	55.164	40.606
.8840	28·5	7.3701	303.93	55.132	40.629
.8835	28·6	7.3660	304.10	55.101	40.652
.8830	28·7	7.3618	304.27	55.070	40.675
.8825	28·8	7.3576	304.45	55.039	40.699
.8820	28·9	7.3535	304.62	55.008	40.722
.8815	29.0	7.3493	304.79	54.977	40.745
.8810	29·1	7.3451	304.96	54.945	40.768
.8805	29·1	7.3409	305.14	54.914	40.791
.8800	29·2	7.3368	305.31	54.883	40.814

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S.GALLON	U.S.GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON
.8600	32·9	7.1700	312.41	53.636	41.763
.8595	33·0	7.1659	312.59	53.604	41.787
.8590	33.1	7.1617	312.77	53.573	41.812
.8585	33.2	7.1575	312.96	53.542	41.836
.8580	33.3	7.1534	313.14	53.511	41.861
.8575	33·4	7.1492	313.32	53.480	41.885
.8570	33·5	7.1450	313.51	53.449	41.909
.8565	33·6	7.1409	313.69	53.417	41.934
.8560	33·7	7.1367	313.87	53.386	41.959
.8555	33·8	7.1325	314.05	53.355	41.984
.8550	33·9	7.1284	314.24	53.324	42.008
.8545	34·0	7.1242	314.42	53.293	42.032
.8540	34.1	7.1200	314.61	53.261	42.057
.8535	34.1	7.1158	314.79	53.230	42.081
.8530	34.2	7.1117	314.97	53.199	42.106
.8525	34.3	7.1075	315.16	53.168	42.131
.8520	34·4	7.1033	315.34	53.137	42.155
.8515	34·5	7.0992	315.53	53.106	42.180
.8510	34·6	7.0950	315.72	53.074	42.205
.8505	34·7	7.0908	315.90	53.043	42.230
.8500	34·8	7.0867	316.09	53.012	42.255

SPECIFIC GRAVITY	BEAUME SCALE	POUNDS PER U.S.GALLON	U.S.GALLONS PER TON	POUNDS PER CUBIC FOOT	CUBIC FEET PER TON.
.8500	34·8	7.0867	316.09	53.012	42.255
.8495	34·9	7.0825	316.27	52.981	42.280
.8490	35·0	7.0783	316.46	52.950	42.304
.8485	35·1	7.0742	316.65	52.918	42.329
.8480	35·2	7.0700	316.83	52.887	42.354
.8475	35·3	7.0658	317.02	52.856	42.379
.8470	35·4	7.0617	317.21	52.825	42.404
.8465	35·5	7.0575	317.39	52.794	42.429
.8460	35·6	7.0533	317.58	52.762	42.454
.8455	35·7	7.0491	317.77	52.731	42.480
.8450	35·8	7.0450	317.96	52.700	42.505
.8445	35·9	7.0408	318.14	52.669	42.530
.8440	36·0	7.0366	318.33	52.638	42.555
.8435	36·1	7.0325	318.52	52.607	42.580
.8430	36·2	7.0283	318.71	52.575	42.605
.8425	36·3	7.0241	318.90	52.544	42.631
.8420	36·4	7.0200	319.09	52.513	42.656
.8415	36·5	7.0158	319.28	52.482	42.681
.8410	36·7	7.0116	319.47	52.451	42.707
.8405	36·8	7.0075	319.66	52.419	42.732
.8400	36·9	7.0033	319.85	52.388	42.758

TABLES SHOWING PHYSICAL PROPERTIES OF OILS USED FOR LIQUID FUEL

be the case if a tank had small horizontal dimensions combined with considerable depth. But in the tank of ordinary proportions the error from this source may be important. The settling tank is the most convenient place in which to measure the consumption of oil for short periods of time, and in such tank the error in capacity due to only ¼ inch error in the sounding has been known to exceed four percent of the amount of fuel oil in the tank at the time the soundings were made—enough to materially affect the figures for fuel economy.

The second method of measurement in common use, by "ullage," is used almost exclusively by the owners of vessels used for transporting oil in bulk; and as it is customary to check all receipts and deliveries of the oil by this method, its continued use is good evidence of its superior accuracy.

In using this method, recent practice is to place a small hand-hole as near to the center of the tank as possible, the opening being provided with an oil-tight cover which is secured so as to be readily opened by the removal of a toggle pin. No sounding pipe is fitted (though there should be one fitted, for reasons that will appear later), and measurements are always taken from the top edge of the handhole rim to the surface of the liquid. This distance is known to those in the oil carrying trade as the "ullage" of the tank.

It is evident, upon comparing this method of measurement with the first, that the measurements are less liable to be in error (even when made by unskilled men), for the following reasons:

(*a*) There is no possibility of foreign substances, sediment, or cement affecting either the ullage measurement or the capacity calculations.

(*b*) There is no chance of error because of knuckles in the sounding pipe.

(*c*) As the sounding rod does not come in contact with the bottom of the tank, errors from that source are avoided.

(*d*) The thickness of the tank top plating and the depth of the handhole rim are quite easily measured and can be accurately allowed for in making the capacity scales or diagrams.

(*e*) Capacity scales, made to read ullage depths, are used and understood as easily as those made to suit soundings.

Granting, then, that by the ullage method of measurement the amount of oil can be accurately determined, there remain four other measurements which for some vessels must be included in the engineer's reports, namely, draft of the vessel forward and aft, the list of the ship and whether to starboard or port, the temperature of the liquid fuel, and also the specific or Baumé gravity of the liquid fuel. These will be considered in the order given.

Where the tanks used for measuring the fuel are short in proportion to the length of the vessel, the draft carefully read by eye from the draft marks is sufficiently accurate for all practical purposes. When, however, the tank is relatively long, or extreme accuracy is for any reason desirable, internal draft gages should be fitted to make exact draft readings possible. These gages are made of a glass tube or tubes of sufficient length to cover the range of the draft of the vessel, open at the upper end to the air and connected to the sea at the lower end through a valve which serves to shut off the connection when the tube is not in use, and also to check the motion of the water in the tube, due to the influence of the waves, by partially closing the valve and so wire-drawing the flow of water. A drain-cock is fitted to clear the gage of water after it has been in use, and also to allow a flow of water to be maintained through the pipe before readings are taken so that the water in the pipe will be of the same temperature and specific gravity as the sea water at the time the draft readings are taken. A scale, carefully graduated to read heights above the bottom of the keel is permanently secured alongside the glass tube so that the draft of the vessel may be read without the use of a rule.

The list of the ship to starboard or to port should be read from the ship's clinometer in vessels where the sounding tube is not on the center-line of the tank, or the tank or tanks used for measuring the fuel consumption are not symmetrical about their center-lines.

As all liquids expand or contract with changes in temperature, any attempt to obtain accurate records of fuel oil consumption must include a record of the temperature. In bulk oil cargo vessels it is usual to furnish the ship with a thermometer which is known to be accurate, and when the temperature of the oil is required it is lowered by means of a cord or wire, through the handhole, to a position approximately at the center of the volume of the oil. It is allowed to remain there sufficiently long for it to reach the same temperature as the oil, and the reading is taken immediately upon its withdrawal. When the tank is deep and the heavier portion of the oil gravitates toward the bottom of the tank, or when extremely accurate results are desired, the thermometer should be secured within a large weighted bottle, fitted with a stopper which can be pulled out by a separate line after the bottle is lowered in the tank. If the bottle is rapidly drawn to the surface the sample of oil contained can be tested for specific gravity and the temperature determined at the same time. In a deep tank this information should be obtained for at least three different depths, the bottom, the middle and the top of the tank and the average taken for use in obtaining the amount of oil in the tank.

Nearly all large sales and purchases of fuel oil are for a specified volume, either barrels (at 42 gallons per barrel) or gallons, at a temperature of 60 degrees Fahrenheit, and therefore it is customary to correct all measured capacities to the standard temperature of 60 degrees Fahrenheit to render direct comparison of different vessels, or of the same vessel at different times, possible. The rate of expansion, commonly expressed as a coefficient of expansion for one degree, varies with the specific gravity of the oil, but a rate of 1 percent for every twenty degrees Fahrenheit change in temperature (coefficient 0.0005) may be taken as a good average for any oil commonly used for fuel oil.

For an intelligent analysis of the results of the fuel it is necessary to know the grade of the oil used. The grade is usually recognized by the color, smell, specific gravity, flash and firing points of the oil used, but for fuel oil the only property that is ordinarily used is the specific gravity. This is usually given in degrees on the Baumé scale, the hydrometer in common use for this purpose being graduated to that scale.

The equivalent specific gravity, Baumé gravity, weight per cubic foot, cubic feet per ton, weight per U. S. gallon (231 cubic inches), and U. S. gallons per ton are given in the tables (see pages 307 and 308), throughout the range of values required for oils that are used for fuel oil.

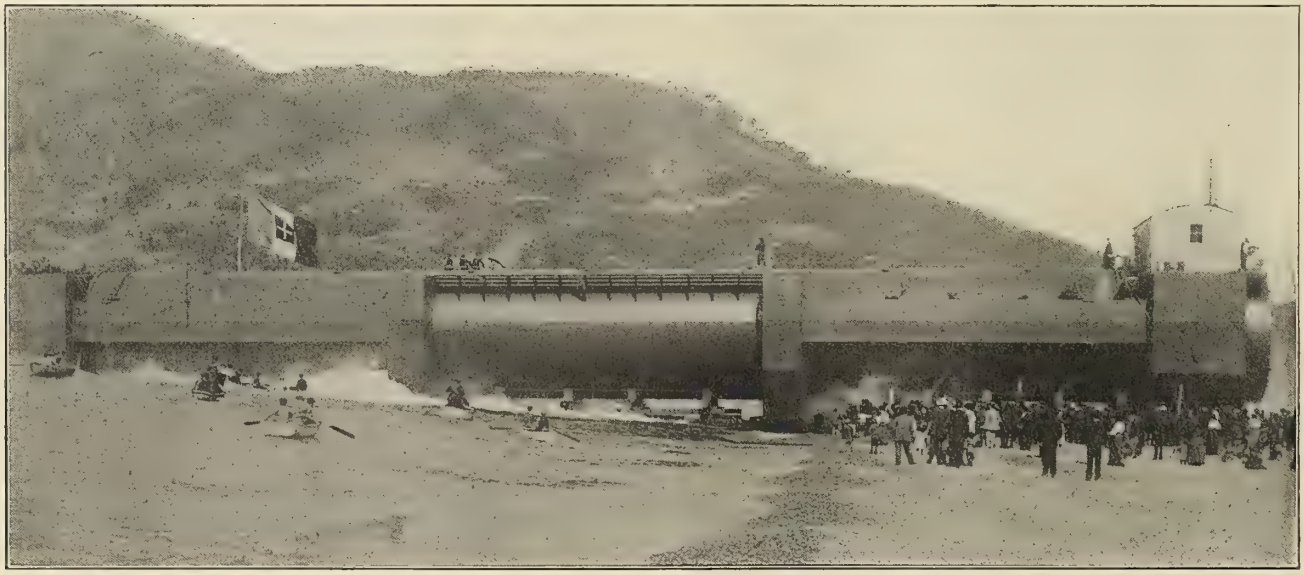
(*To be concluded*)

At a meeting of the Committee of Manufacturers on Standardization of Fittings and Valves, held in New York, July 10, the "Manufacturers'" 1912 Schedule of Flanged Fittings and Flanges was adopted, to take effect Oct. 1, 1912. There was practically no opposition among the manufacturers present to the adoption of this schedule, but one vote being recorded against it. Copies of this schedule will be printed and distributed to the manufacturers and the trade generally as soon as possible. New list prices for brass and iron body swing check valves, standard and extra heavy, were adopted at this meeting, to take effect Oct. 1, 1912, copies of which will be printed and distributed to the trade as promptly as possible.

A Combined Salvage and Testing Dock for Submarine Boats

BY ROBERT G. SKERRETT

The Italian Government, within the past few months, has added a novel auxiliary to its naval facilities. This is a combined salvage and testing dock for under-water boats. The primary purpose of the apparatus is to provide a safe and flexible means for trying out submarines under circumstances duplicating the stresses of deep submergence without actually sinking the boats to depths of corresponding hydrostatic pressure. This means that the subaqueous vessel can be tested at any convenient place—preferably the building yard—instead of taking her to some out-of-the-way part of the coast, perhaps exposed, for the purpose of finding water deep enough for actual submergence so many feet down. In the very deep trials for hull strength, generally no one goes down in the boats, and much information could be obtained were inspectors aboard at that time. However, as things are, the element of risk seems to be too great to warrant the hazard of human life, and yet the safety of the crew later on may hinge on the very data which are now not attainable as the tests are ordinarily conducted. The existing facilities employed in this work here are not flexible enough to lend themselves readily to a secure and speedy handling of the submarine when lowered to great depths and with examiners on board. In brief, this is the general state of the art so far as testing facilities for under-water boats commonly exist, but fortunately the special dock just added to the Italian navy promises a revolution and a very material betterment in the dealing with problems associated with some phases of under-water navigation.

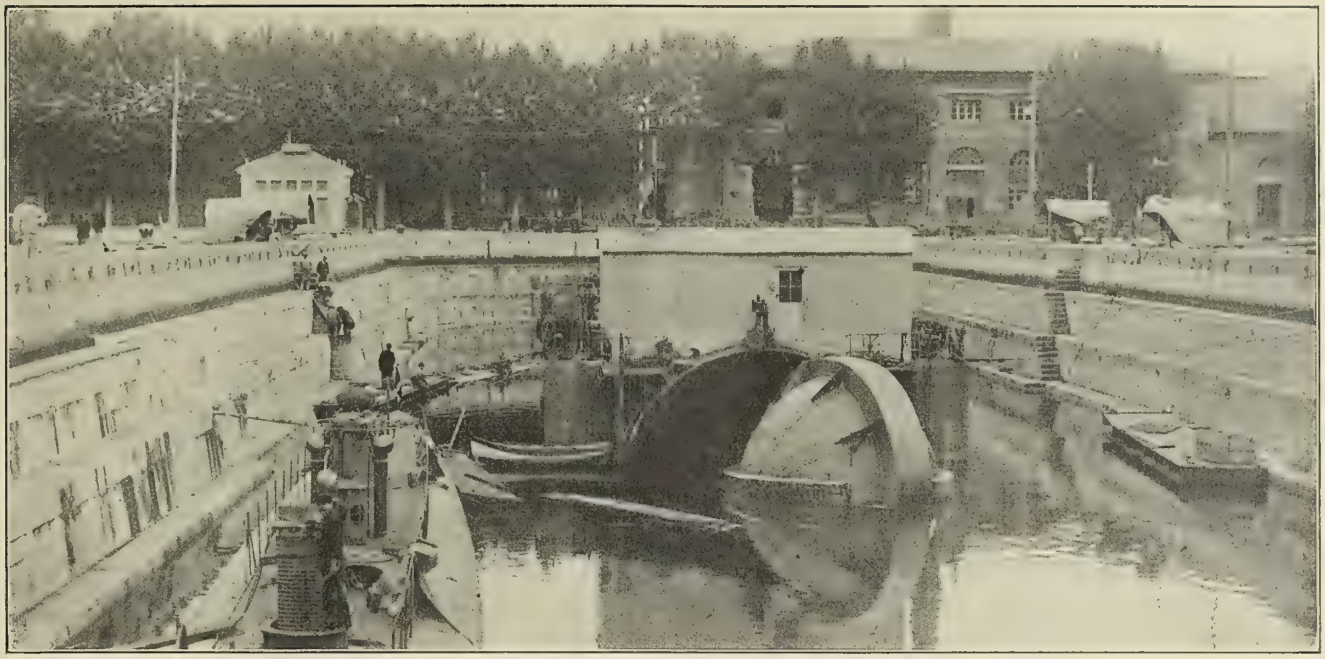


LAUNCH OF THE LAURENTI SALVAGE AND TESTING DOCK AT SPEZIA

Designs are already prepared for a dock of this sort large enough to meet the requirements of a submarine quite 200 feet long and having a displacement of possibly 400 tons or more. An apparatus of these proportions would have an overall length of about 235 feet, and, empty, a displacement of 500 metric tons upon a mean draft of 7 feet. At its deepest draft, when flooded and submerged sufficiently for the entrance of a submarine, the dock would have an average draft of 17 feet 9 inches. With the dock closed and ready to be docked itself, with a submarine inside, the mean draft would be substantially 10 feet. This would be the condition, too, with the dock in a state to test a submarine under pressure—the space around the submarine being flooded.

The general arrangement of the dock is quite simple, and one cannot help but marvel at the delay in its development, remembering as we do the number of accidents which resulted fatally because of insufficient structural strength. The testing dock consists fundamentally of a cylindrical steel body or tube of such strength that it can endure safely a bursting pressure exerted by contained water equivalent to a sea pressure at a depth of more than 300 feet. This tubular body is permanently closed at one end, and at the other there is a removable caisson or stopper which closes the opening through which a submarine may enter or leave the dock. The inside of the tube has a series of rails upon which can be laid keel blocks to support the vessel undergoing test, and other blocks or chocks secure the boat in position so that she cannot shift vertically when the cylinder is flooded. The cylinder is sustained by encompassing caissons, which are flooded or drained as occasion requires in order to sink or raise the dock bodily. The water entering the tubular structure does so through the ballast tanks, and is again withdrawn through the same channels. This simplifies operations and facilitates a nicer control of the water. When the submarine has been landed, so to speak, inside of the dock, the movable gate is swung into position and the cylinder sealed.

In order to subject the submarine to external stress, pressure is applied to the water filling the tube, and surrounding the submarine, by means of a special steam pump. Gradually the pump forces the pressure higher and higher until the desired limit is reached—all the while the boat is really only at normal surface and lying, perhaps, right at the wharf of the shipyard; but, even more important than this, observers are inside the submarine and are able to watch every physical effect of the crushing pressures exerted upon the hull. The examiners are in touch by telephone with the operators of the dock and the pressure pump, and complete co-operation is thus secured—it being possible to reduce the stresses very quickly should any serious or dangerous signs of yielding manifest themselves. The conditions involved in the applica-

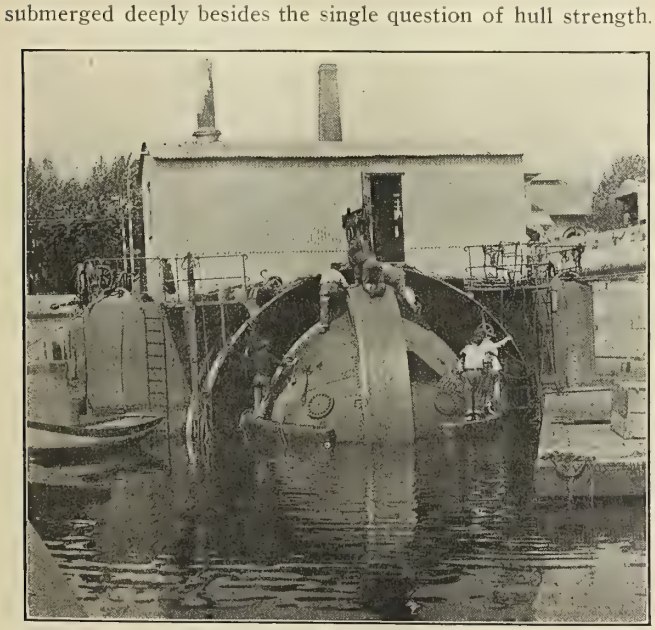


ENTRANCE GATE BEING SWUNG TO ONE SIDE PREPARATORY TO ADMITTING SUBMERSIBLE TO DOCK

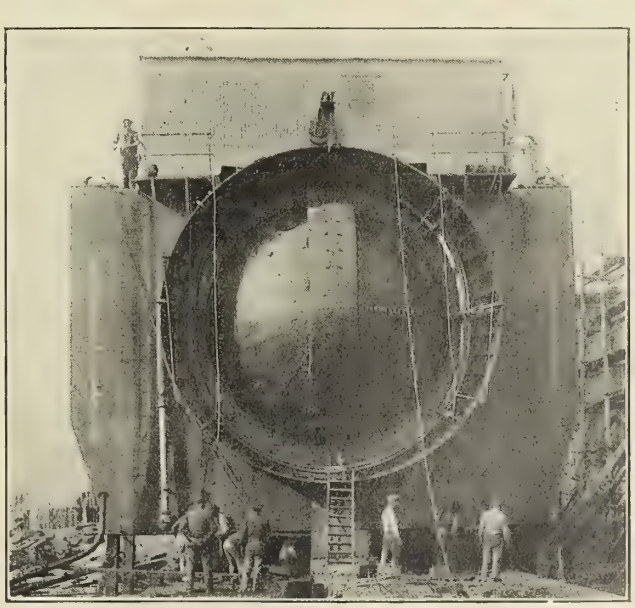
tion of the Laurenti dock are thus a very happy contrast to those present at the general function of a deep trial submergence for hull strength. Besides eliminating a large element of guesswork, the Laurenti apparatus makes it possible to obtain definite and conclusive data which are now denied by the physical circumstances of testing and the absence of inspectors during the deep submergence of the submarine. The time element which bears importantly upon the problem can be lengthened to any desired period, and the submarine in the testing dock can be held at a chosen pressure—corresponding to a given depth—as long as there is any need. All of these functions can be executed without regard to the state of the weather and the condition of exposed water, and a maximum depth of less than 20 feet is sufficient to meet every requirement. This is certainly a contrast to going somewhere off the coast and sending the submarine down 200 feet attached to the clumsy, slow-working facilities of an ordinary wrecking derrick.

There are other things that affect the safety of a submarine submerged deeply besides the single question of hull strength. These are the manner of working of the pumps designed to handle ballast against high external pressures; the sufficiency of the air system to expel water under similar conditions; the water tightness of torpedo tubes, certain stuffing boxes, and kindred outboard passageways; and, equally vital, the proper seating and strength of sea valves and allied connections which may be directly exposed to external pressures. The Laurenti dock makes it possible to answer all of these questions completely and satisfactorily. A boat so tested can be put into service with an assured margin of safety which would not only mean greater security for her crew, but possibly a degree of operative efficiency which must now be largely a matter of speculation in some directions.

We must not forget that submarine navigation has been a practical and commercial accomplishment of scarcely more than a term of ten years, and within the last five years tremendous advances have been made. In a large measure much of this improvement is due to changes in the form of hull—breaking away from the traditional spindle of circular cross-section. The gradual trend toward a modified shipshape body,



CLOSING THE ENTRANCE GATE



ENTRANCE END OF DOCK CLOSED

so as to get relatively high speeds, both submerged and on the surface, associated with seaworthiness, has added expense and structural difficulties in order to obtain the needful unit strength of section. This has introduced some factor of doubt, because all of these changes of form are based upon empirical formulæ. Now the Laurenti dock gives to the designer an instrument by which experimental sections can be submitted to test at small expense, and changes in the weights of parts and arrangement of the material can be studied practically at first hand. This obviates the building of an entire submarine speculatively and deferring knowledge until after a heavy outlay—knowledge which, when it arrives, may bring disappointment. In a sense, then, the invention of Major Cesare Laurenti is a counterpart, in its particular department, of the advantages to be obtained by the broadly recognized model experimental basin. It permits the attainment of information in advance of construction, which is of prime importance, and it also reduces the testing of the submarine already built to a line of scientific procedure which can not fail to furnish invaluable data.

The dock, as built for the Italian Government, carries its own power plant, and is furnished with both steam and electric pumps, the latter being of the centrifugal type and designed to handle the water ballast generally. The dock has no powers of self-propulsion, and must be towed from place to place if needed. This would probably be required should the dock be used for salvage purposes. It has a lifting capacity of more than 400 tons, and this would be ample to raise a sunken submarine, enough to carry her into shallow water or, perhaps, into harbor for dry-docking. The Laurenti dock is provided with the equipment needful to carry out an operation of this sort. This gives us a fairly good idea of the comprehensive capacity and flexibility of application of this Italian innovation.

The submarine has brought its own problems, and these can be mastered or met only by providing proper auxiliaries. The parent ship was the first of these adjuncts, the salvage dock, pure and simple, was the next, and now we have the composite creation designed by Major Laurenti, which may quite truly be said to be the present climax of associate equipment.

Latest Clyde-Built Scout Cruiser

The *Dublin*, recently launched from the Naval Construction Works of Messrs. William Beardmore & Company, Dalmuir, is one of three vessels of the "Town" type under construction—the *Chatham*, launched at Chatham in November last, and the Southampton, under construction at Clydebank, are her sister ships. Of the "Scout" class of cruiser twenty-one vessels have been constructed, and the following shows the Clyde-built specimens and their gradual development in size and power:

	Feet.	Tons.	H. P.	Knots.	Builders.
Foresight Forward	360	2,850	15,000	25.00	Fairfield.
Glasgow	430	4,800	22,000	25.00	Fairfield.
Gloucester	430	4,800	22,000	25.00	Beardmore.
Bristol	430	4,800	22,000	25.00	Clydebank.
Falmouth	430	5,250	22,000	24.75	Beardmore.
Yarmouth	430	5,250	22,000	24.75	London & Glasgow Co
Dublin	430	5,400	25,000	25.5	Beardmore.
Southampton	430	5,400	25,000	25.5	Clydebank.

The speeds of the completed vessels have been remarkably good, and in every case the contract has been well exceeded. The *Glasgow* attained a speed of 26.7 knots, the *Gloucester* 26.3, and the *Bristol* 26.8, while the *Falmouth* and *Yarmouth* were equally successful. In the *Bristol* and *Yarmouth* Brown-Curtis turbines, with a twin-screw arrangement, were installed and have proved most economical. The *Southampton* has a similar installation. The others had Parsons turbines and four screws, and this arrangement is adopted in the *Dublin*.

The advancement in displacement from the initial cruisers of this type has been caused by the increase in armament, better protection and increase in the radius of action. The *Foresight* and *Forward* mounted fourteen 12-pounder guns, had a coal capacity of 380 tons, and an armored deck 1½ inches in thickness. The *Dublin* mounts eight 6-inch guns and eight smaller weapons, has a capacity for 1,000 tons of coal, and, besides having protective deck, has armored protection on the sides. This departure is the feature of the new vessels, which in size and power approach first-class cruisers. The type has not advanced in length, being still about 450 feet, but their breadth, draft and displacement have been increased gradually in each succeeding naval programme, and in the *Dublin* they reach a beam of about 50 feet, with a displacement of 5,500 tons and a draft of 16 feet. The increase of about 15 percent in displacement has been utilized to improve the seagoing qualities of the vessels and to provide increased protection and more powerful armament.

In appearance the new scout vessel resembles the other cruisers of the "Town" class with four funnels and two masts. Steam will be supplied by twelve boilers of the Yarrow type, fitted for liquid fuel as well as for coal. The estimated cost of the *Dublin* is $1,630,000 (£334,058), and of the *Southampton* $1,620,000 (£333,078). The new vessels, of greater displacement, are being built cheaper than the earlier and smaller ships. In the vessels of 4,800 tons displacement the *Bristol* cost $1,780,000 (£365,000), or $370 (£76) per ton, the *Glasgow* $1,730,000 (£355,000), or $360 (£73.9) per ton, and the *Gloucester* $1,725,000 (£354,000), or $359 (£73.7) per ton. In the vessels of 5,250 tons displacement the *Falmouth* cost $1,650,000 (£337,500), or $314 (£64.3) per ton, and the *Yarmouth* $1,724,000 (£353,238), or $328 (£67.28) per ton. The new vessels show a corresponding decrease. The estimated cost of the *Dublin* works out at $302 (£61.86) per ton, and that of the *Southampton* $301 (£61.68) per ton. This shows an average reduction of $58.5 (£12) per ton in four years.

The keel of the *Dublin* was laid on April 6, 1911. The average time taken for the construction of ships of this class is about twenty months. The *Dublin* should therefore be commissioned about November.

During the year ended June 30, 1912, there were built in the United States and officially numbered by the Bureau of Navigation, 1702 merchant vessels of 243,792 gross tons, compared with 1,208 of 302,158 gross tons for the same period of 1911, showing a loss of 58,366 tons. Of the 35 metal vessels built on the Great Lakes, the *Col. James M. Schoonmaker* and *William P. Snyder, Jr.*, each of 8,603 gross tons, are the largest on the Lakes. Fourteen others, aggregating 30,029 tons, were built for the Atlantic trade. Over 50,000 gross tons of sailing vessels were lost at sea during the year, equivalent in tonnage to vessels built of this class for the last three years.

The returns compiled by *Lloyd's Register of Shipping*, which only take into account vessels the construction of which has actually begun, show that, excluding warships, there were 529 vessels of 1,774,040 tons gross under construction in the United Kingdom at the close of the quarter ended June 30, 1912. The tonnage now under construction is about 87,000 tons more than that which was in hand at the end of last quarter, and exceeds by 298,000 tons the tonnage building in June, 1911, the present figures being the highest ever recorded in the society's quarterly returns. The figures for warship tonnage, 503,003 tons, are also record figures; the previous highest total of 454,110 tons having been attained in March, 1900.

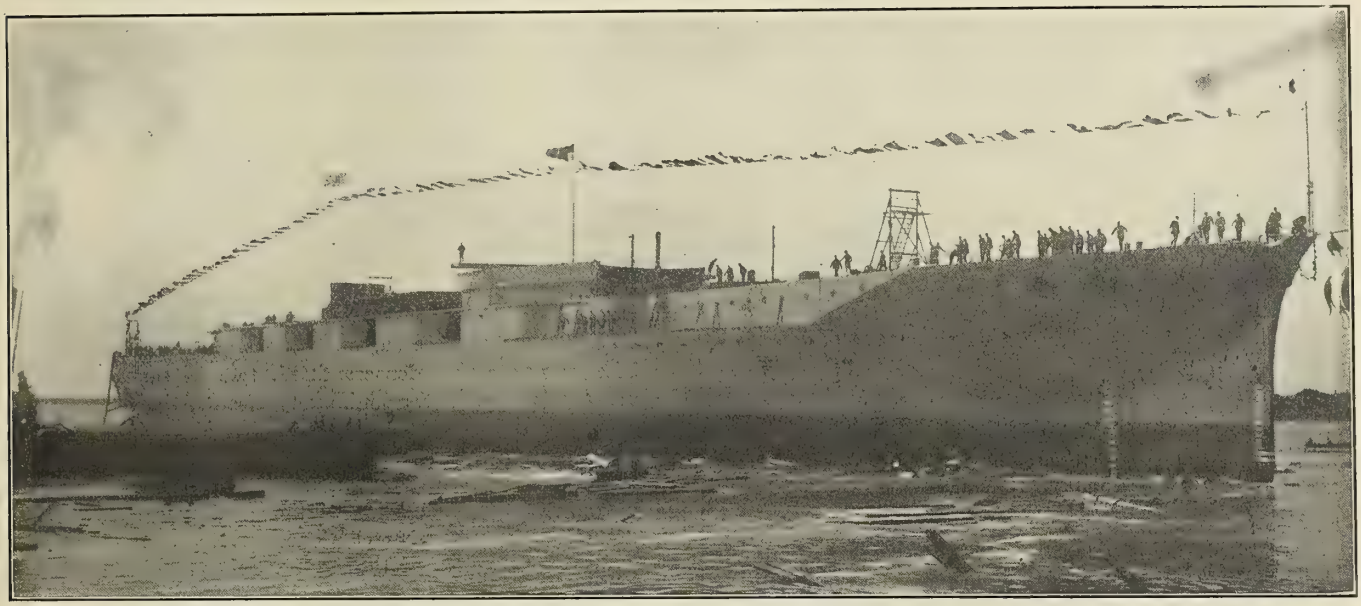
The New Japanese Battle Cruisers—Launch of the Kongo

BY F. C. COLEMAN

Four battle cruisers are now being completed for the Japanese navy, the strategical and tactical qualities governing the design having been enunciated by the Japanese Navy Department from experience gained in the Russo-Japanese war, while it was left to Messrs. Vickers, Ltd., of Barrow-in-Furness, to embody the stipulated requirements, which included the armament, the arrangement of the armament, the speed and radius of action on the smallest and most economical ship, alike in respect to first cost and fuel consumption for all speeds, and the expenses of maintaining the ship in commission.

Three of these battle cruisers are being built in Japan—the *Hiyei* at Yokosuka dockyard, the *Haruna* at Kobe, and the *Kirishima* at Nagasaki, while the fourth, the *Kongo,* is being constructed by Messrs. Vickers, Ltd., at Barrow-in-Furness, to fire all four guns astern in line with the keel. It is important to note that the Japanese authorities have considered it necessary to arrange that four guns should be fired astern.

An important development was also introduced in connection with the 6-inch guns, which are of 50 calibers in length. These are fitted in casemates on the upper deck level. The advantage achieved in the design of these casemates is that the guns can be trained through a wide arc. This general policy is consistent with the arrangement made since the war by the Japanese authorities, who have in all cases adopted, in addition to the primary guns, a large battery of 6-inch weapons, a quality which has since become general among all naval powers. The sixteen smaller guns are placed in convenient positions on the superstructure, in order to command a high elevation.



JAPANESE BATTLE CRUISER KONGO IMMEDIATELY AFTER LAUNCHING

The vessels have the following leading dimensions: Length, 704 feet; breadth, 92 feet; draft, 27 feet 6 inches; displacement, 27,500 tons; service speed, 28 knots; maximum coal capacity, 4,000 tons; oil fuel capacity, 1,000 tons; shaft-horsepower, 70,000. The armament comprises eight 14-inch, sixteen 6-inch and sixteen smaller guns, with a considerable number of submerged broadside torpedo tubes.

It is of interest to note that the 14-inch gun has been adopted in these ships for the first time in battle cruisers, and only after extensive experiments by the Japanese naval authorities with 12-inch, 13½-inch and 14-inch guns, and due consideration of the relative advantages of still larger weapons. The eight 14-inch guns are mounted in pairs in four barbettes, two of which are located forward and two aft, all on the center line. These barbettes are arranged, and the elevation of the guns is fixed, so that four may fire forward and four aft, while all eight may fire on either broadside. The guns to the rear of the bow barbette are at a higher elevation, and in the case of the two after barbettes the forward pair are at a higher elevation, although, owing to the relative positions of the one to the other, the difference in height is not so great as in the forward guns; but, owing to the absence of any obstruction abaft the guns, it is possible

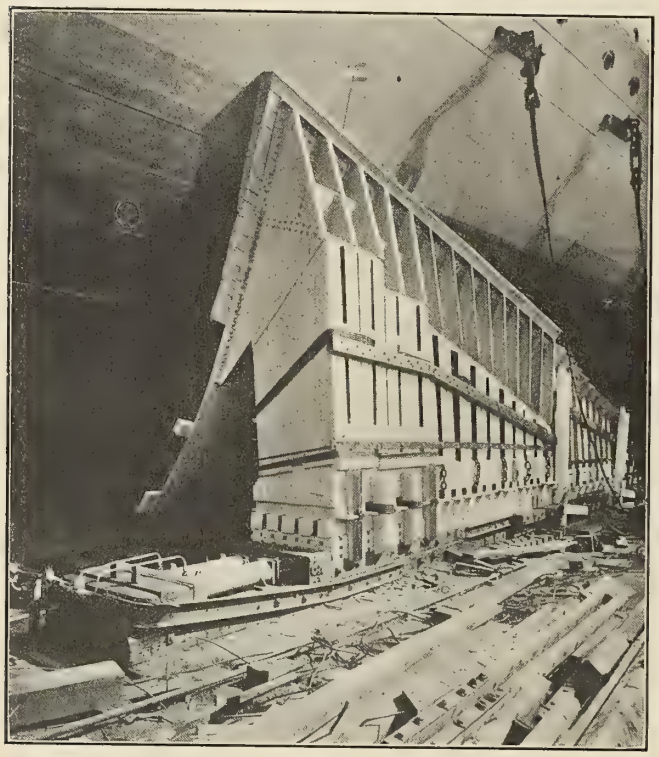
Notwithstanding the very powerful armament provided the armored protection is most effective, particularly against torpedo attack. Indeed more weight has been allotted to this than in most ships. The main broadside armor is of special quality steel, and is equal in thickness to that of any battle cruiser yet designed, and is carried to the height of the boat deck, which is continued on the same level as the forecastle, forming a gun-citadel, into which the 6-inch gun casemates are worked. The main belt extends considerably below the waterline, and under this again there is an auxiliary armor belt extending some distance below the normal armor shelf. There is a special arrangement of armored bulkheads protecting the vital parts of the ship; the magazines, for instance, being completely surrounded with special steel armor. There is an armored deck at the waterline level, and in addition to this there is an armored deck closing in the ship from stem to stern at the level of the top of the side armor.

In the case of the propelling machinery the same idea of adopting the best practice of the moment has been carried into effect; the watertube boilers burn oil fuel as well as coal; the turbines are of the combined impulse and reaction type, and in the details and in auxiliary engines several interesting improvements have been effected. To ensure safety,

the boilers are arranged in eight compartments, four on each side of a center-line bulkhead, which extends throughout their entire length, while the coal bunkers are also disposed to afford protection. Again, the engines—two sets of turbines on four shafts—are arranged in two compartments, with a center-line bulkhead between them. The condensers, four in number, are placed aft of the turbines in two separate rooms, together with centrifugal pumps and other auxiliaries.

The whole of the arrangements, including those of the steam and exhaust piping, feed, drain and oil lubrication systems, are such as to preserve the independence of the port and starboard sets of machinery, and allow either set to be worked when all parts of the other are disabled. Thus steam can be got from any of the eight boiler rooms.

Each set of turbines consists of one high-pressure and one low-pressure turbine, the former being coupled to the outer



BOW CRADLE ON PORT SIDE

and the latter to the inner line of shafting on each side of the center line. Both the high and low-pressure astern turbines are incorporated in the after end of the same casings as the corresponding ahead turbines, and thus all four shafts are available for astern working. The working steam pressure at the engines is 205 pounds per square inch.

The high-pressure ahead and astern turbines are, as already indicated, of the Parsons combined impulse and reaction type, each being provided with an impulse wheel at the high-pressure end. Each impulse wheel carries a single stage of impulse blading, consisting of four rows of rotating blades with their corresponding guide vanes. The nozzles are arranged in groups, in such a way that a high initial pressure may be maintained when the turbines are working at reduced powers, as the supply of steam may be shut off from one or more of such nozzle groups. Following the impulse blading are the usual stages of reaction blades, seven in number in the case of the ahead turbine, while the astern impulse wheel is succeeded by two short stages of the reaction blading. Great care was bestowed upon the design of the blading of the impulse stages, and particularly upon the method adopted for its attachment to the rotors. With the exception of the last row of moving blades, which are of brass, these blades are of special nickel-coated mild steel, welded onto sectional foundation rings of mild steel. The foundation rings are dovetailed into grooves on the wheel rim, to which they are fixed by brass packing calked into one side of the groove. The rotor drums, spindles, connecting pieces and impulse wheels are made of forged steel; the rotor wheels are of forged steel of the arm type.

The combined high-pressure ahead and astern arrangement, together with the introduction of impulse wheels and a two-stage cruising element in one casing, necessitated the construction of a turbine of exceptionally large over-all dimensions. These features constituted a departure from the usual practice in marine turbines of high power, and it was generally found necessary to exercise great care in preparing the detail designs of the rotors and casings, so as to ensure sufficient strength and freedom from distortion under the varying steaming conditions which will obtain on service.

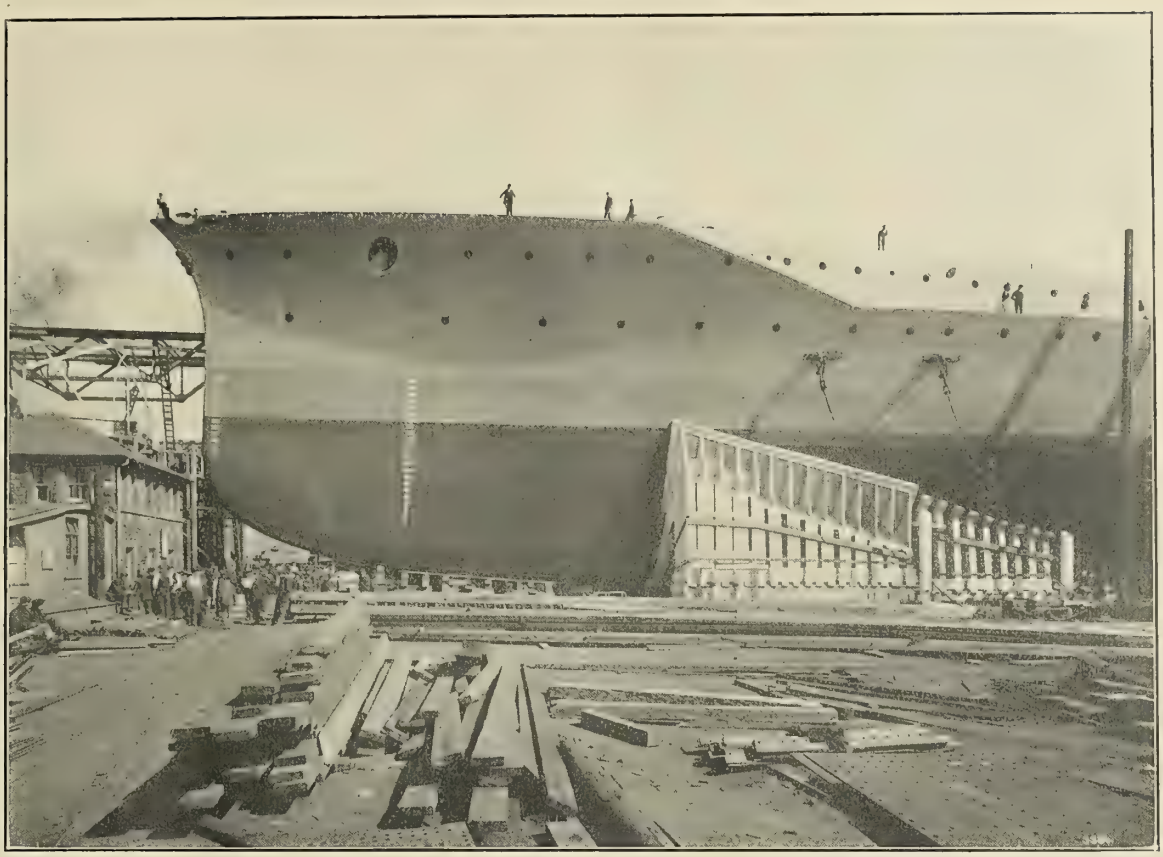
The two low-pressure turbines are on the reaction principle throughout. The object kept in view in the general design of these turbines has been the maintenance of a high economy, not only at full power but also at the lowest anticipated cruising powers under service conditions.

The turbine and propeller shafting are of forged steel, bored hollow throughout the whole length of the shaft. Thrust and adjusting bearings are fitted to each line of shafting. The screw propellers are four in number, three-bladed, the material being of manganese bronze, the blades and boss forming one casting. Complete forced lubrication arrangements are provided for the turbine and plummer-block bearings, the oil being supplied by direct-acting pumps, two of which are fitted in each of the four engine rooms. The oil is passed through coolers of the tubular type, the circulating water for which is supplied by a direct-acting pump fitted in each of the four engine rooms.

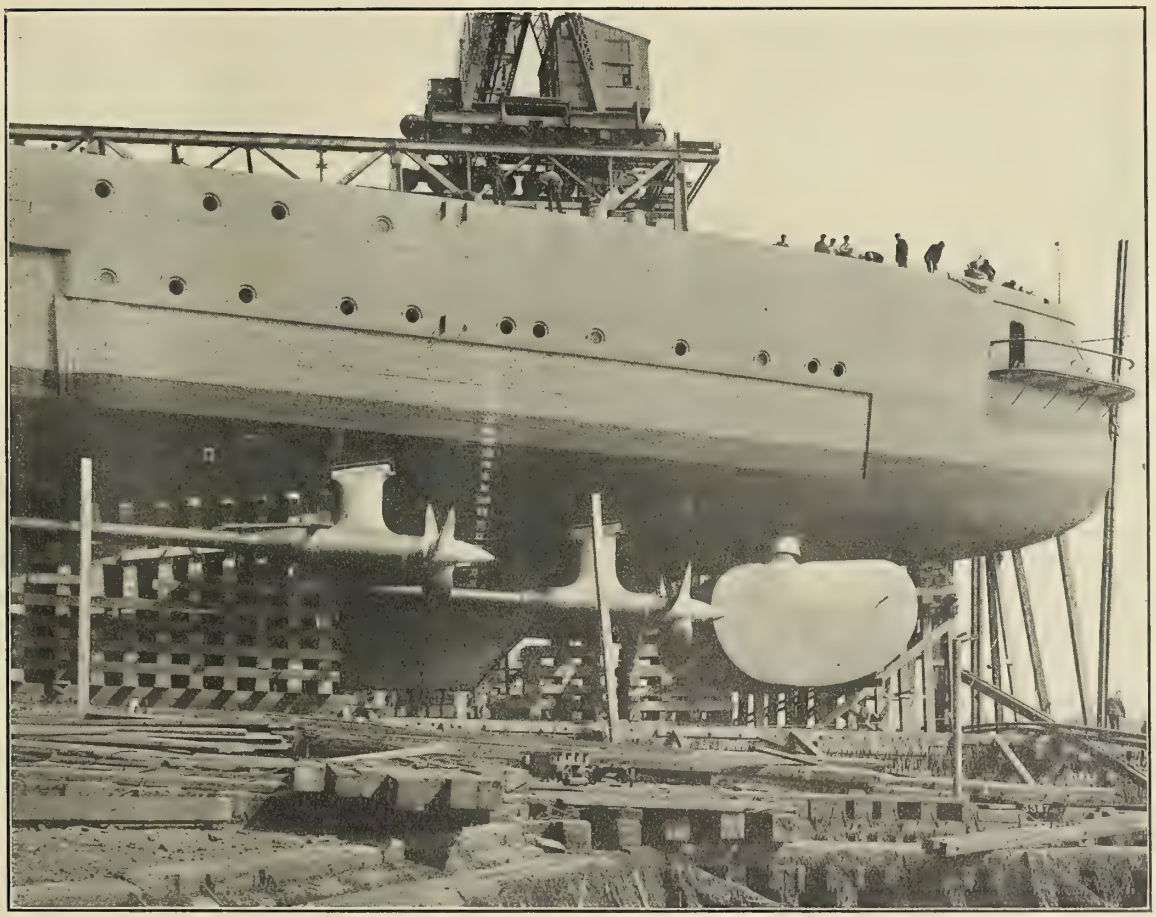
The four main condensers fitted, two in each condenser compartment, are of the Uniflux type, with the tube casings built up of steel plates and angles. The end covers are of cast iron, to protect the tubes, etc., from galvanic action. There are two independent air pumps for each pair of main condensers, the pumps being of the Dual type, each having one air and one water barrel. The circulating pumps for the main condensers are of the centrifugal type, two for each pair of main condensers. The pumps are driven by independent two-crank engines fitted with forced lubrication. Two auxiliary condensers, one in each condenser compartment, take the exhaust steam from the auxiliary machinery. In connection with the auxiliary condensers two air and two circulating pumps are provided.

In the boiler room there are eight main and eight auxiliary feed engines of the direct-acting type; the capacity of the auxiliary feed service is equal to that of the main. There are four grease extractors in connection with the delivery pipes of the main air pumps and two for the auxiliary air pump discharges. Fourteen steam pumping engines are fitted for fire and bilge purposes and for emptying the double bottoms of the compartments. Four of these pumps are fitted in the engine rooms and the remainder in the boiler compartment; those fitted in the boiler rooms are also capable of being used in connection with the See ash ejectors, ten of which are provided.

The thirty-six watertube boilers in the ship are of the Yarrow large-tube type, arranged to pass the products of combustion into three funnels. They are loaded to 275 pounds pressure per square inch, and are arranged to work under forced draft with closed stokeholds. The boilers are arranged to burn oil fuel as well as coal; a complete installation of pumps, heaters, filters and collectors, with all connections, being provided and fitted complete for this purpose. Electrical indicators for regulating the firing of the boilers are fitted



VIEW OF KONGO WITH CRADLE READY FOR LAUNCHING



VIEW OF STERN SHOWING PORT PROPELLERS AND RUDDER

complete in the boiler room, the furnaces being numbered to correspond with numbers which are periodically displayed on the indicator dials. Five steam-driven air compressors are fitted for cleaning the boiler tubes externally by air jet.

The fans for supplying forced draft to the boilers number thirty-four—thirty-two of the single-breasted and two of the double-breasted type. They are driven by double-acting steam engines fitted with forced lubrication. The six evaporators are worked with steam taken from the auxiliary steam service. The two distilling condensers are of the cylindrical type, capable of condensing all the steam from any four of the evaporators. All the evaporators are connected so that any of them can deliver their vapor either to the distiller or the auxiliary condenser in their own compartment.

While Messrs. Vickers are to be congratulated on having combined on such a comparatively small displacement the satisfactory fighting qualities enumerated alike in regard to gun power, armament, speed and radius of action, it should be remembered that the elements of design were, as we have already explained, laid down by the Japanese authorities.

The *Kongo* was launched at Messrs. Vickers' naval construction works, Barrow-in-Furness, on May 18 last, and the photographs reproduced illustrate the cruiser in various stages of construction and after being floated. Not only by reason of the design of the ship, but also because her launching weight was greater than that of any war vessel previously floated, the occasion was vested with considerable interest.

The total launching weight carried on the standing ways was 13,220 tons, with a mean pressure on the ways of only 1.98 tons per square foot. The ship, it may be noted, has a length of 704 feet and a beam of 92 feet, and the standing ways, made for the most part of pitch pine, had a length of 682 feet. The sliding ways, of oak forward and pitch pine aft, were 538 feet 6 inches long, the ship having an overhang forward of 74 feet 6 inches, owing to the very fine entry, and of 90 feet aft, due to the cut-up of the stern to suit the propellers and rudders. The keel of the ship had been laid on a declivity of 16.5/32 inch per foot, and the declivities of the standing and sliding ways, respectively, were:

Declivity of Ways (in 1/32 inch Per Foot)

	Standing Ways	Sliding Ways
At fore poppet	12.3	12.3
At center of length of standing ways	18.35	17.1
At end	24.4	21.8

The construction of the cradle, both forward and aft, is well shown in the photographs. The forward is the more interesting. The practice of securing the heads of poppets in some form of metal structure—cast, bolted up or riveted to lie snugly into the form of the ship—has been adopted for some considerable time. In this case the structure was of steel plates and angles, with web brackets for stiffening purposes. This structure was not secured in any way to the ship, but was packed up with timber between the skin plating and the main plates of the cradle. These plates extended under the keel between the port and starboard sides of the cradle. This arrangement not only obviates any possible strain on the ship's structure, but, while cradling the ship snugly, enables the cradle to fall away as soon as the ship is waterborne.

Consideration was given to ensure as wide a distribution as possible of the maximum thrust upon the ways when the stern began to float. This downward thrust was experienced when the ship was 220 feet from the end of the seaward ways. In order that the consequent pressure should be distributed over the greatest possible length, layers of soft wood (spruce) were introduced in the lower part of the packing forward. The location of this packing, and its extent relative to the total area of the sliding ways, were determined with due regard to the pressures which it was calculated would be exerted at various points forward, owing to the gradual rising of the stern. The success of this proportioning of area is established by the fact that there was not the slightest suggestion of heat or firing due to friction on the ways, as is often the case.

The use of the spruce had the further effect of cushioning the force exerted on the fore poppets when the stern became water-borne. This was of consequence, in order to obviate any excessive stress on the cradle, or indeed on the vessel itself.

In order that the extent of crushing could be ascertained, a gage was set up consisting of a wire-rope connection from the bottom of the sliding ways up to the deck of the ship, where it passed over a pulley, a weight and recording disk being arranged. By this means it was ascertained that the maximum extent of crushing was 6 inches, which was at the forward end of the cradle. An examination of the spruce afterwards recovered from the water showed that the permanent compression of the material was only 1 inch.

In order to indicate on the launching platform the rise of the tide, not only on the launching ways but at the Ramsden dock, through which the vessel had to pass to the fitting-out berth, there was applied the Gardner-Ferguson patent electric transmitter, which indicated on a dial on the launching platform the rise of the tide in inches at both points by means of electric apparatus actuated by floats. Thus those in charge of the arrangements were able to ascertain when the launch could take place, which was within three seconds of the anticipated time.

The method of releasing the ship followed the practice established by experience. There were two pairs of dog-shores, and in addition three pairs of triggers held in position by hydraulic rams; the releasing of the water in the cylinders enabled the rams to recede and the triggers fell from the vertical to the horizontal position, thereby unlocking the sliding ways. Two rams were placed under the stem to assist in the taking out of the keel blocks. Four rams were located at the head of the standing ways in order that, if necessary, the sliding ways could be given an impulse. This, however, was found unnecessary. The ship began to move as soon as the hydraulic triggers were released, and the time taken for the first foot of travel was thirteen seconds, and for the remaining 681 feet forty-five seconds. The maximum velocity was 25½ feet per second, equal to 15 knots, and this was when the vessel had traveled through 500 feet.

There was used a simple method of recording the speed at various points. The instrument used consists of a drum 10 feet in circumference, carrying 3/16-inch log wire 1,200 feet long, the drum being capable of taking the whole length in one lap. This drum is mounted by nuts on a screwed spindle, fixed in bearings on standards with set-pins. As the wire pays out the drum rotates on the screwed spindle at a speed exactly corresponding to that of the ship, and at the same time the drum travels axially along the screwed spindle. For record purposes there is attached to the winding drum a cylinder carrying the recording paper. The diameter of the cylinder is arranged directly proportionately to the diameter of the paying-out drum, so that one revolution of the recording cylinder represents a given length of travel of the ship. The instrument is fitted with an electric chronometer, marking on the paper every half second of time, while a pencil records the rate of travel of the cylinder. To control the rotation of the drum there is fitted outside of the nut connection to the screw a brake, to ensure that the wire is always taut. This instrument gives the speed throughout the whole of the travel of the ship.

To bring the ship up when afloat, chain drags were used,

there being six sets on each side of the ship, each composed on an average of about 20 tons, the total weight of drags being 740 tons. The drags began to take effect after the ship had left the ways 10 feet, and from this point until the ship was brought to rest the vessel traveled 220 feet. There were also two stern anchors in order to assist in swinging the ship into line with Walney Channel. The strong tide running, owing to the direction of the wind, caused the ship to swing quickly. She was ultimately taken in charge by tugs and safely moored under the 150-ton crane at the Buccleuch Dock, where she will be fitted out.

It may be added that the vessel had, before launching, all her boilers on board, as well as all the auxiliary machinery, the only exception being the main turbines and the four condensers. A considerable amount of the armor, nearly one-fourth of it, has been fitted on board, and the location of the armor was determined in order to give an even keel when afloat.

Results of Experiments with a Watertube Boiler, with Special Reference to Superheating*

BY HAROLD E. YARROW

The objections which have hitherto been raised to superheating for marine work are:

(1) Owing to the dryness of the steam, oil for the internal lubrication in recoprocating engines becomes a necessity, and the oil, finding its way into the boiler, leads to trouble.

(2) The probability of burning the superheater when the passage of the steam through it is suddenly reduced or stopped.

By the introduction of turbines the difficulty of lubrication does not occur, and with regard to burning the superheater tubes the arrangement we adopt avoids this risk.

The boiler with which these tests were made was of the Yarrow type, and was fitted up in our experimental shop, which is equipped with the necessary plant for making very complete tests. Throughout the experiments oil fuel only was used, and as it is possible with oil to maintain steady and uniform working conditions, very accurate results were obtained, which would not have been possible with coal, in which case irregularity of stoking and other sources of discrepancy occur. During the experiments careful records were taken of the oil consumed, the water evaporated, steam pressure, temperature of the superheated steam, and the temperature of the gases at various points during their passage past the boiler tubes.

As is well known, superheating is very largely adopted in land installations, and in locomotives it is being rapidly introduced. From information kindly given us by the locomotive superintendents of the main railway lines in this country, it appears that the economy realized in locomotives due to superheating averages fully 20 percent in fuel consumption, and rather more in water consumption. It may perhaps surprise many marine engineers to know that on the Great Western Railway alone no fewer than 500 locomotives are now running fitted with superheaters. Taking the average of several land turbine installations, there is found by superheating to 100 degrees F. to be a saving in consumption of fuel of from 8 to 10 percent, and in steam consumption from 10 to 12 percent. The reduction in steam consumption is specially important for marine work, as it enables a reduction to be made in the size and weight of the condensers, air pumps, circulating pumps and feed pumps, and probably of the distilling plant. Independent of the gain directly due to superheating, the risk of water passing into the turbine from any cause whatever is reduced, and the fear of damage in consequence of water causing the stripping or cutting of the blades is diminished, and any additional cost of up-keep of the superheater will doubtless be fully balanced by the diminished risk of injury to the turbine blades by the action of water when using saturated steam.

Turning now to the design of the boiler and superheater with which the various experiments were carried out, I beg reference to Fig. 1, which shows a cross section of the boiler, and it will be seen that it consists of a top steam collector, as usual, and two lower water pockets. On the left-hand side the superheater is shown, and it will be observed that on this side of the boiler there are fewer rows of generator tubes than on the other side, where there is no superheater, it being thought desirable that the total heating surface and the resistance to the gases on both sides of the boiler should be approximately the same. The total heating surface of the boiler was 6,700 square feet, of which 1,265 square feet consisted of superheating surface; the total heating surface on the superheater side of the boiler was 3,453 square feet, and on the other side 3,247 square feet.

The superheater consisted of a number of "U" tubes expanded into two longitudinal collectors, small doors being fitted so that access could be obtained to the tubes when required. The leading feature of the arrangement is that the superheater is placed on one side of the boiler only, and a damper is fitted in the up-take on the same side, as shown on the diagram. If this damper is closed the whole of the gases are deflected towards the opposite side of the boiler, and no heated gases pass the superheater, the object being that if the main engines should be suddenly eased or stopped, or when raising steam, the superheater may be shut off, so as to prevent the tubes being damaged, or the steam being superheated to an excessive extent, owing to there not being sufficient circulation of steam. In this way one objection to the introduction of superheating for marine installations is overcome.

A further advantage of this arrangement is that when the consumption of steam is suddenly reduced or stopped, not only does the damper prevent the superheater tubes from being burnt, but it also greatly diminishes the output of the boiler at the time when a reduced supply of steam is wanted, because only about one-half of the heating surface comes into contact with the hot gases. To avoid the possibility of the damper getting distorted through over-heating, it is provided with a hollow spindle, to which air is admitted, and which passes from thence between the two plates of the damper, escaping at the edge, and thus keeping the damper cool. This arrangement of damper has proved thoroughly successful under the most trying conditions.

In order to carefully measure the temperature of the superheated steam and of the gases, a complete installation of thermometers and pyrometers was fitted to the boiler, and

* Read before the Institution of Naval Architects, March, 1912.

TABLE A

TRIALS WITH DAMPER OPEN

Heating surface { Large Nest of Generator Tubes = 3,247 square feet / Small Nest of Generator Tubes = 2,188 square feet / Superheater = 1,265 square feet } 6,700 square feet total.

On these trials the heating surface is taken as the total heating surface of 6,700 square feet.

Steam Pressure Pounds per Square Inch.	Superheat in Degrees Fahrenheit.	Air Pressure, Inches of Water.	Pounds of Water Evaporated per Hour.	Pounds of Oil Fuel Burnt per Hour.	From and at 212 Degrees Fahrenheit.		Pounds of Oil Fuel Burnt per Square Foot of Heating Surface per Hour.	Temperature of Feed Water, Degrees Fahrenheit.	Temperature Between Small Nests of Generator Tubes and Superheater, Degrees Fahrenheit.	Temperature of Uptake, Degrees Fahrenheit.	
					Pounds of Water Evaporated per Pound of Oil per Hour.	Pounds of Water Evaporated per Square Foot of Heating Surface per Hour.				Above Superheater.	Above Large Nest of Generator Tubes.
242.	93.5	5.0	94,659	8,286	14.6	18.0	1.237	58.0	1,121	828	887
243.	93.0	3.16	76,021	6,454	15.0	14.4	.9635	63.5	926	698	727
243.7	82.5	2.44	68,387	5,695	15.2	12.9	.850	63.5	903	685	688
242.8	61.1	1.7	46,041	3,630	15.9	8.6	.542	64.0	647	536	551
241.8	31.0	.998	20,059	1,540	16.1	3.7	.230	62.2	481	432	448
242.2	20.75	.625	8,478	649	16.1	1.55	.096	63.5	465	409	416

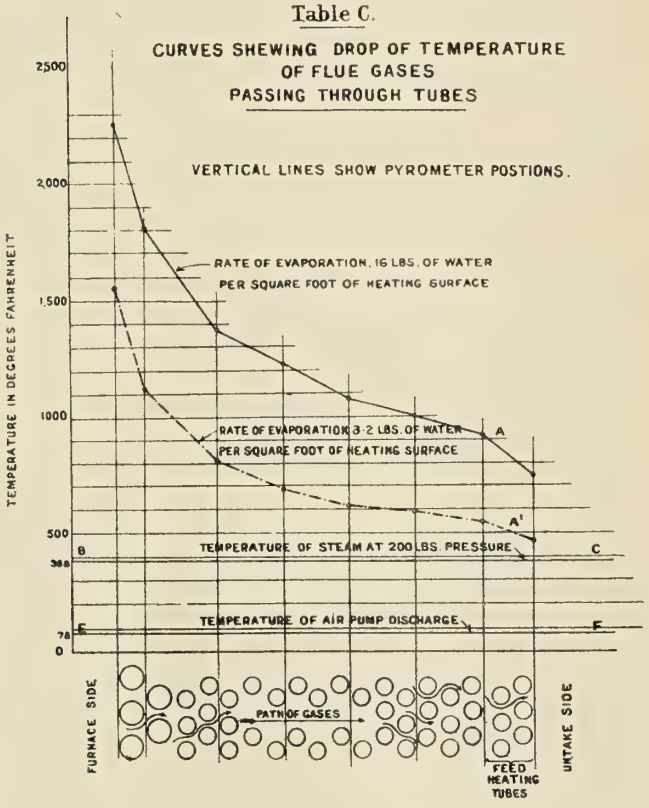
TABLE B

TRIALS WITH DAMPER SHUT

Heating surface { Large Nest of Generator Tubes = 3,247 square feet / Small Nest of Generator Tubes = 2,188 square feet / Superheater = 1,265 square feet } 6,709 square feet total.

On these trials the heating surface of boiler is taken as heating surface of Large Nest of Generator Tubes = 3,247 square feet.

Steam Pressure, Pounds per Square Inch.	Air Pressure, Inches of Water.	Pounds of Water Evaporated per Hour.	Pounds of Oil Fuel Burnt per Hour.	From and at 212 Degrees Fahrenheit		Pounds of Oil Fuel Burnt per Square Foot of Heating Surface per Hour.	Temperature of Feed Water, Degrees Fahrenheit.	Temperature of Uptakes, Degrees Fahrenheit above Large Nest of Generator Tubes.
				Pounds of Water Evaporated per Pound of Oil per Hour.	Pounds of Water Evaporated per Square Foot of Heating Surface per Hour.			
242.0	4.85	68,648	6,287	13.25	25.66	1.936	61.0	913
242.25	3.97	57,693	5,065	13.84	21.6	1.56	60.0	843
242.4	2.491	44,050	3,504	15.3	16.5	1.09	60.3	673
242.5	1.46	31,481	2,473	15.4	11.75	.76	63.5	603



we have to thank the director of the National Physical Laboratory, Dr. Glazebrook, and also Dr. Harker, for the assistance which they kindly afforded us in the selection of the most reliable instruments for this purpose.

Turning to Table A, giving particulars of one series of the trials with the damper open, it will be seen that the results are given for six rates of evaporation. It will be observed that at the maximum rate of evaporation, namely, when burning 1.237 pounds of oil per square foot of heating surface per hour, the degree of superheat was 93 degrees F. Corresponding figures are given at the lower rates of evaporation.

We now pass to similar trials with the damper closed, and on these the heating surface of the boiler is assumed to be that of the large nest of generator tubes only, as all the gases have to pass on that side of the boiler. The results of this series are shown on Table B.

As one of the objects of the marine engineer is to obtain more and more steam out of a given weight of boiler, we thought it would give useful information to make tests burning oil fuel at a rate of consumption considerably greater than has hitherto been the custom, to ascertain if the boiler would, under such conditions, show any defects. It will be seen from Table B that at the highest rates of evaporation nearly 2 pounds of oil per square foot of heating surface per hour were being consumed, if we disregard the heating surface on the superheater side of the boiler. Thus the surface on the opposite side of the superheater was subject to the heating effect of all the gases plus half the radiation. Every part of the boiler withstood the severe test, and trials burning this quantity of fuel were made on several occasions.

The results of other experiments indicate that in a properly designed boiler of the type we are dealing with, it is possible

to burn, without injury to the boiler, 2 pounds of oil per square foot of heating surface per hour.

Since these experiments were carried out the official trials have taken place with one of the destroyers built by us for the British Admiralty, H. M. S. *Archer,* in which boilers fitted with superheaters were provided. The result of these trials showed that the gain we expected was fully realized, and on the full-speed trial the degree of superheat at the turbines was 94 degrees F.; the shaft-horsepower developed was slightly over 18,500, which compares with about 17,000, which is the shaft-horsepower we should have expected had the boilers been of the usual type. The mean speed obtained on the six runs on the measured mile at Skelmorlie was 30.9 knots, and the mean speed for eight hours 30.3 knots, the contract speed being 28 knots.

One point to which Mr. Charles Merz (to whom I am greatly indebted for much valuable information) has drawn attention is the necessity, with the use of superheated steam, of efficiently covering the high-pressure portions of the turbine cylinder with non-conducting material, because the

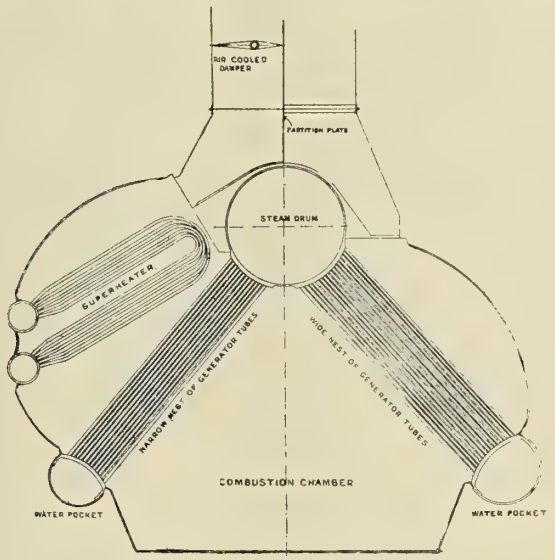


FIG. 1

metal on the inside of the cylinder in contact with the steam becomes hotter than that on the outside, especially at the edges of flanges and ribs. The inside tends to expand, and this expansion is resisted by the colder metal on the outside; consequently, if the temperature difference is great enough, the metal will be distorted, and perhaps strained beyond its elastic limit. For this reason the design of the ribs should be carefully considered, the thickness of metal throughout the structure being kept as uniform as possible.

These experiments were also the means of pointing out to us another important improvement in the Yarrow boiler, and Fig. 2 has been prepared, which illustrates the ordinary type of boiler without superheater, from which it will be seen that the last two rows of tubes farthest from the fire are partitioned off for the feed water to ascend. When working the boiler *at high rates of evaporation* we found that notwithstanding all possible precautions, even with turned rivets and carefully reamered holes, we were unable to prevent the riveted seam of the water pockets from leaking. We found the pocket was sometimes hot and sometimes cool; indeed, in places sufficiently cool to be able to bear one's hand on it. These trials were frequently repeated with the same result, and we ultimately found out the cause. The fact was that the suction down the tubes which were in close proximity to the feed-heating tubes was so great that the cool feed water which had passed up the feed-heating tubes was instantly drawn down into the water pocket without having had time to mix with the hotter water in the upper chamber, as indicated by the arrow in Fig. 2. This action took place intermittently, and the water pockets locally changed their temperature, one portion of the water pocket being one minute hot and another minute comparatively cool, dependent upon the working of the feed pump. The strain thus thrown on

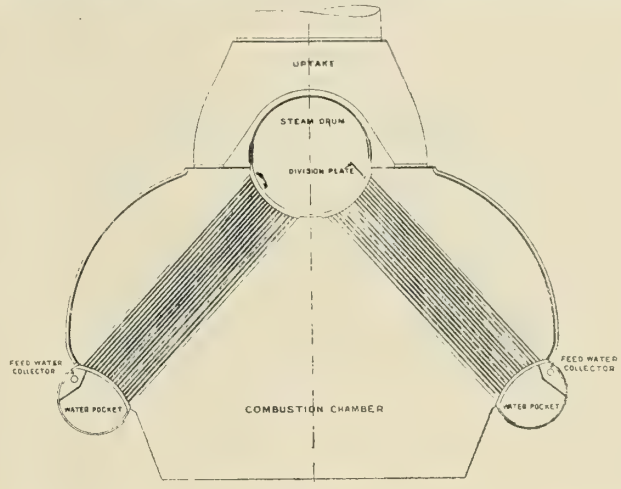


FIG. 2

the metal of the water pockets by this short-circuiting of the feed was evidently severe, and resulted in the leakage of the seams. Having discovered the cause of our trouble it was not difficult to find a remedy. It was found that by simply placing a longitudinal partition plate in the upper chamber, so as to avoid the short-circuiting of the feed, all difficulties disappeared. This plate is shown on the right-hand side of the diagram only, but in practice it would, of course, be fitted

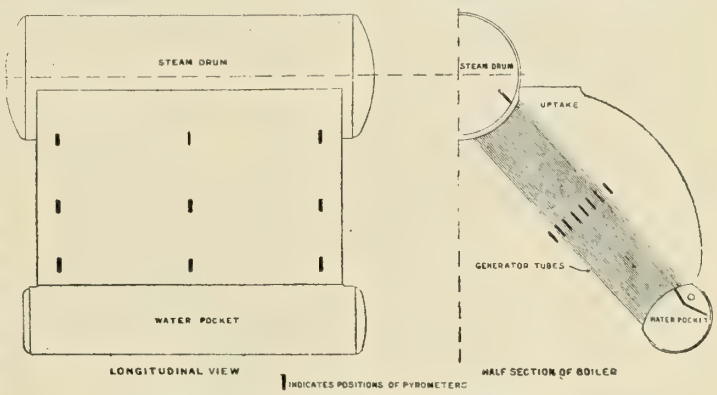


FIG. 3.—SHOWING POSITIONS OF PYROMETERS

on both sides. The same trouble has before been met with, especially abroad, but the true cause was never suspected; it was generally put down to inferior workmanship. Even when no trouble is experienced, it is evident that serious and undesirable strains must at times be taking place, which may in the end lead to the failure of the metal, due to constant fatigue. By the fitting of this partition plate, however, all such strains are eliminated.

Fig. 3 has been prepared to show the positions of the pyrometers.

Table C shows the temperature of the gases at various points in the boiler. The vertical lines correspond to the position of the pyrometers, as shown in Fig. 3. The upper curve indicates the gas temperatures at a rate of evaporation of 16 pounds of water per square foot of heating surface, and the lower curve represents the gas temperatures at a rate of evaporation of slightly over 3 pounds per square foot of

heating surface. The horizontal lines represent temperatures, and the line *B C* represents the temperature of the steam at 200 pounds pressure, and the line *E F* the temperature of the air pump discharge taken at 78 degrees F.

It will be observed, the very great drop in temperature which takes place during the passage of the gases through the first rows of tubes, showing the large proportion of heat that

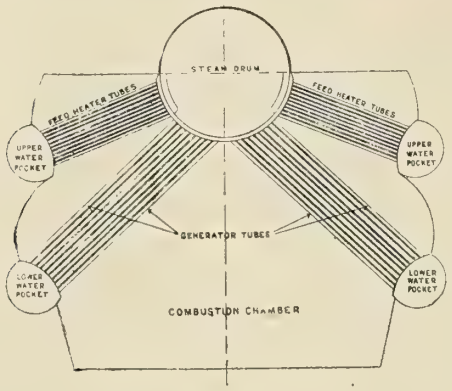


FIG. 4

is taken out of the gases by these tubes. Also it will be observed, that there is a sudden drop in the temperature at *A* and *A'*; that is, where the gases pass through the last rows of tubes. This is due to the fact that the cold feed water (which enters a portion of the water pocket) abstracts a greater amount of heat from the gases in ascending the two outside rows of tubes than would be the case if these tubes were full of water at the temperature of the steam.

Referring to Table C, given in diagram form, it will be seen that the temperature of the gases at the point *A'*, *i. e.*, just prior to the gases passing the feed-heating tubes, is about 550 degrees F., and the temperature of the steam at 200 pounds pressure is 388 degrees F., a difference of only 162 degrees, whereas the temperature of the air pump discharge of 78

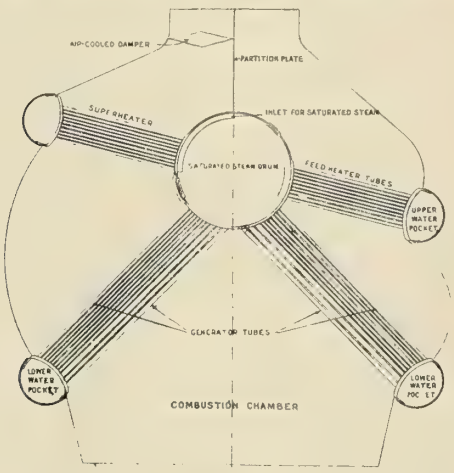


FIG. 5

degrees F. gives a difference of 472 degrees. This clearly shows the gain due to this system of feed heating, and the desirability of extending it, which can be effected by having separate water collectors and feed-heating tubes apart from the main water collectors and main generator tubes, *i. e.*, there would be two water collectors on each side of the boiler, the tubes connected to the top one acting as a feed heater, and such a design of boiler is shown (Fig. 4).

It should also be pointed out that there is a supplementary and an important advantage in this feed-heating, namely, that any grease or sediment that comes over with the feed is deposited in these tubes, which are not subject to fierce heat, rather than in those nearer the fire, which are exposed to the intense radiation of the furnace, and thus the life of the boiler is prolonged. With the introduction of oil fuel some such arrangement is the more necessary, because it has been

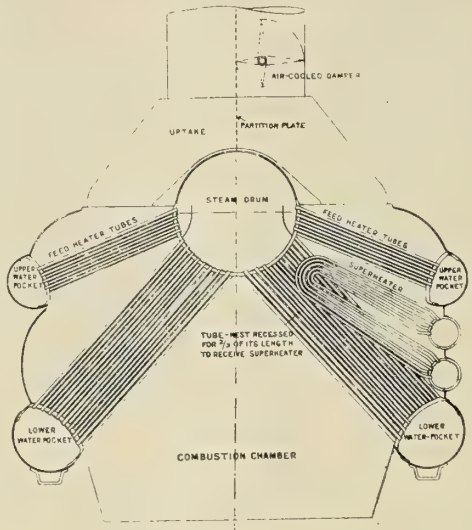


FIG. 6

found that the oil heaters leak, with the result that oil mixes with the steam and passes ultimately into the boiler.

As I thought it would interest the meeting to indicate some of the arrangements for superheating and feed heating which may be adopted with a view to still further improving the results in connection with such a boiler as the one we are dealing with, I beg your reference to three illustrations.

Fig. 5, it will be seen, shows the superheating tubes united to the steam drum, and to a steam receiver sufficiently large for a man to enter, the tubes being expanded at both ends.

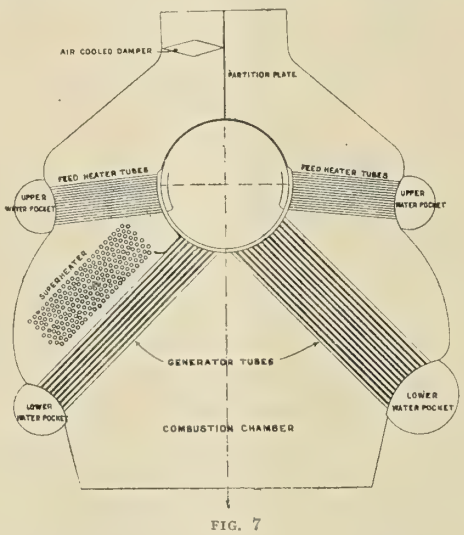


FIG. 7

In this arrangement all the tubes are straight, a condition much appreciated by many authorities, and also there is an additional advantage by this system, as the superheating tubes on the one side of the boiler and the feed-heating tubes on the other side of the boiler are of such a length that they can be withdrawn and replaced from inside the steam drum.

Fig. 6 shows a set of U-shaped tubes placed between the generator tubes and the nest of feed-heating tubes, the nest of generator tubes being recessed for about two-thirds of its length to receive the superheater. The ends of the superheater tubes are expanded into two longitudinal steam re-

ceivers. This arrangement will probably be the most efficient for a given quantity of heating surface.

Fig. 7 shows the superheater tubes placed at right angles to the generator tubes. This arrangement has the advantage that all the tubes are straight. I would mention that the arrangement of running the tubes at right angles to the generator tubes has already been adopted in boilers of certain warships constructed by Messrs. John Brown, and also by ourselves, with the exception that a superheater was fitted on both sides of the boiler, and was, therefore, not under the same control as in the case of the superheater fitted only on one side in conjunction with a damper.

It is proposed in some cases to have an additional damper on the opposite side to the superheater, the two dampers being arranged so that either can be open, or both open, but under no condition can both be closed. This enables the superheater side of the boiler to be used to a greater or less extent as desired. When cruising at a slow speed this arrangement may possibly lead to a more economical result than if both sides of the boiler are equally free for the passage of the hot gases.

Judging by the best practice in land installations, 100 degrees F. superheat is by no means the limit that can be adopted with advantage. It is reasonable to suppose that the requisite condition to be desired is that the steam should remain in gaseous form as far as possible during its passage through the turbine, because any condensation that takes place must diminish the energy given out by the steam to the blades of the turbine, also while the steam remains in gaseous form the steam friction is reduced.

I would submit, from the results of the accumulated experience of others, and from our own experiments, that there will be a certain gain by the use of superheated steam of from 8 to 10 percent in fuel economy when using 100 degrees F. of superheat, and from 11 to 13 percent gain when using 150 degrees F. of superheat in combination with a pressure of 200 pounds per square inch.

Also, a further gain in fuel economy can be obtained by an efficient system of heating the feed from the gases after they have passed the generator tubes, so that some of the remaining heat should be absorbed which would otherwise be lost.

Although the experiments were made with an oil-burning boiler, the various arrangements as shown in the diagrams would be equally suitable if coal were used, and there is no reason to suppose that similar advantages could not be obtained.

With regard to the relative weights of boilers, with and without superheaters, provided the total heating surface were the same, there would be no appreciable difference. If, however, the complete machinery installation is taken into account, there would probably be a small saving in weight in the case of the installation with superheated steam. I would therefore submit that in the propelling machinery of warships improved results can be obtained by superheating, without increased weight, cost, space or up-keep, and a further extension of feed heating by the waste gases.

It may be of interest for me to describe a further experiment which has been made bearing on the value of superheating.

Referring to Fig. 1, an additional damper was fitted on the side opposite to the superheater, and on a vessel a trial was made during a given time with the damper on the superheater side open and the other damper closed, so that all the gases would have to pass by the superheater. On this trial a speed of 15 knots was obtained, the degree of superheating being limited to 100 degrees F.

Another trial was then made of the same duration, burning the same amount of oil, and in every respect similar, but with the damper on the superheater side closed and the other damper open, thus only using saturated steam, and it was found that the speed at once dropped from 15 to 13 knots.

This clearly proves the gain due to superheating, which enables the cruising speed to be raised from 13 to 15 knots with the same consumption of fuel, or a corresponding increase in radius of action at 13 knots. These are results which have been actually obtained, and which we are prepared to repeat.

Commercial Motorboats Gaining Favor

The *Captain Collier,* illustrated herewith, shows how the gasoline (petrol) engine is taking its place in shipping and freighting work. Owing to the low first cost, low maintenance cost and the great economy in intermittent service, the slow-speed heavy-duty gasoline (petrol) engine offers exceptional advantages in boats built for or adapted to this kind of service to-day. And this is especially so where the lower and cheaper grades of gasoline (petrol) are used as fuel.

The *Captain Collier* was completed several months ago by the Cramp Ship Building Company, Philadelphia, Pa., for the Guffey Petroleum Company, and has been used in continuous service since. She is 109 feet long, 22 feet beam and 7½ feet draft. She has eight 8,000-gallon tanks, having a collective

THE CAPTAIN COLLIER, A MOTOR TANK BOAT

capacity of 64,000 gallons. Besides having room for a large deck load, she has storage space in the forward hold for the carrying of 100 barrels, the vessel being equipped with derrick and power hoist for the handling of barrels and case goods cargo.

The power plant consists of two 90-100 horspower Standard gasoline (petrol) engines, which give the vessel a speed of 8½ miles per hour. She is also equipped with a Standard 4½ kilowatt dynamo directly connected with the Standard auxiliary engine, with air pump and bilge pump attached. The boat is electrically lighted and very completely equipped.

As can be seen from the picture, she is a thoroughly wholesome type of vessel. So well do her owners look upon her work that they are now building a new vessel 150 feet long to be equipped with a single 300-horsepower, reversing-type Standard engine and auxiliaries. This vessel is building at the Skinner Ship Building Yard, Baltimore, Md.

H. M. S. Firedrake, one of the three special destroyers ordered by the Admiralty last year from Messrs. Yarrow & Company, of Glasgow, completed her official full-speed trials June 29, on the Skelmorlie course, attaining during a continuous run of eight hours a mean speed of 33.17 knots, thus exceeding the contract speed of 32 knots by 1.17 knots. The vessel is 255 feet long by 25 feet 7 inches beam, and is propelled by Parsons turbines driving two shafts, steam being supplied by three Yarrow watertube boilers fitted with the firm's latest feed-heating devices.

Common Sense in Engineering*

BY WALTER M. McFARLAND

From the very nature of things, education in our academies and schools is largely a matter of books, calculations and drawings, and while an enormous amount of valuable information and training is obtained in this way there is one absolutely vital element to success which may be, and often is, entirely neglected. This element is what we generally call common sense, but experience goes to show that it is very far indeed from being common. What we really mean by common sense is sound judgment, or the application of our knowledge and experience in an intelligent way to problems which we have to solve. It cannot be learned from books directly, and to a certain extent it is a natural gift, but there is no question that with care and attention it may be developed. I have already remarked that it is a vital element of success, and I may add that some of the most brilliant engineers whom I have known have spoken of it as more important than all their skill in mathematics, physics or any of the other sciences.

In the law schools it is now quite common to give instruction by what is known as the "case system," instead of by laying down abstract principles. That is to say, a specific case is taken up and studied and the principles developed from it, the impression being very much more lasting than a discussion of abstract principles without a specific application. In this way I am going to call attention to some very interesting cases of the application of common sense, and also to others where this was entirely lacking, which I hope will teach a useful lesson.

Going away back to the very beginning of the steam engine we find that in the earliest engines a shower of cold water was injected into the cylinder to condense the steam, and the atmospheric pressure on the other side caused the movement of the piston. As we can now see, this meant a horrible waste of steam, because, when steam was first admitted an enormous amount would be condensed against the cold piston and cylinder walls before the piston had reached the top. One of the first things that James Watt did was to remove this cause of waste by inventing the separate condenser. This seems now to have been perfectly obvious, but it took genius, in the form of common sense, to change the practice of many years.

His engines were arranged to use steam expansively, but the pressure was low and the possible range of expansion small. As steam pressures increased some enthusiasts, looking on steam as a perfect gas and forgetting that if it was so readily condensible in one vessel it would be in another, and figuring on great economies from high ratios of expansion, advocated that engines should be designed on this principle. Admiral Isherwood, who was one of the most famous experimenters in marine engineering during the latter half of the last century, had already noticed the discrepancy between the theoretical and actual steam consumption, which his investigations indicated to be due to cylinder condensation. With strong common sense he carried out a series of experiments in 1859 on the steamer *Michigan*, and demonstrated conclusively that with low pressures and slow-running engines a very moderate degree of expansion gave the greatest economy.

During the Civil War Admiral Isherwood was engineer-in-chief of the navy, and designed a very large number of highly successful engines based upon his experiments on the *Michigan*. Some of the advocates of high ratios of expansion could not be convinced by these experiments and persuaded the Department to let them put in engines of their own designs. In every case these were failures, and of a very abject kind.

Another notable illustration of Isherwood's strong common sense was the machinery of the *Wampanoag*. At the time of her trial, 1868, and for more than a decade afterwards, her speed formed the record—nearly 18 knots. While she would now be considered a small vessel of moderate power, at that time she was a large one and with high power. Isherwood felt sure that direct-connected engines of such power in a wooden hull would not give satisfaction, and, accordingly, he used geared engines to increase the speed of the propeller above that of the engine. This was absolutely a matter of common sense and experienced judgment, and the result justified his decision.

More than twenty years afterwards, Admiral Melville, when engineer-in-chief, faced the problem of putting more than 20,000 horsepower in the hulls of the *Columbia* and *Minneapolis*. At that time, 1891, no shafts had ever been built in this country to transmit more than 10,000 horsepower. As vessels with more than two screws had been used earlier with satisfactory results, he decided to fit three screws to these vessels. The reason for doing so, however, was not in anticipation of getting increased speed but solely in order to keep the shafts of a size where it was known that they would be absolutely reliable. As you doubtless know, these vessels were a remarkable success and attained speeds of about 23 knots, which at that time and for some years was faster than any other large vessels, either in the navies or the merchant service throughout the world.

One of Admiral Melville's distinguished characteristics was his splendid common sense. He was one of the most courageous men who ever lived, and like most of such men had the fine qualities of being able to undertake great responsibility and not worry about his decisions after he had reached them. He displayed his common sense in his handling of the introduction of watertube boilers for large vessels in the navy. He believed that watertube boilers would be absolutely necessary on such vessels, in order to meet the demand for large powers in limited space and weight. The torpedo boat boilers, with small, thin tubes, were not sufficiently robust to promise the longevity demanded for the boilers of large vessels. After preliminary tests he made an installation in the monitor *Monterey*. A man who was simply working for newspaper approval would have followed this up by introducing watertube boilers in every new ship; but his common sense told him that it was necessary to wait until there had been time to test the boilers out in actual service. The result was that it was about three years after the *Monterey's* boilers were given their contract trial before he placed an order for other watertube boilers. In the meantime he had concluded that the ones which were installed on the *Monterey* were not the best adapted to navy service, and by feeling his way he decided upon a boiler about which he says in his last published article: "Believing that I had found the boiler best adapted to use on our large war vessels, and confirmed in this view by their performance in service, I continued to install them as long as I remained engineer-in-chief, and my successors have done the same." Meanwhile, in some other navies which made their first installation after Melville had made

*Abstract of an address delivered at the graduating exercises of Webbs Academy, New York, June, 1912.

his, they pushed the matter, with the result that there was much dissatisfaction and great expenses.

When the first vessels of our new navy came out, a form of air pump was used where two water and air cylinders were driven from the crankshaft of a compound engine whose cylinders were fitted with valves arranged, as usual, to cut off about three-quarters stroke. It did not occur to anybody at the time that the work to be done was quite different from that of an ordinary engine, inasmuch as the work at the beginning of the air pump stroke was very little at the time when the steam cylinder was doing its most, and the maximum work of the air pump came at the end of the stroke, when the pressure in the steam cylinder was the least. These pumps and engines gave a great deal of trouble, and had to be run at a very high speed to keep them from stopping. All the designers in the different shipyards tried different methods of remedying the trouble, and finally Capt. Frank Bailey, the chief designer of the Bureau of Steam Engineering, then a passed assistant engineer, applied common sense to the problem. Some of the direct-driven air pumps had been brought out, and they could run at a very low number of strokes without any trouble about stopping. He analyzed their design and was struck by this fact: Their steam ports were only about 3 percent of the area of the piston, while the steam ports in the engines giving the trouble were about 10 percent of the piston area; also, in the direct-driven pumps the valve gear opened the port wide and kept it so until time to close it at the end of the stroke, while in the engine the valve opened slowly to full width and at once began to close. In other words, in the direct-driven pump the port was so small that the pump could not run away, and yet, if the air cylinders were flooded and the pump tended to slow down, the port being wide open permitted the full pressure to come on the piston. Accordingly, Capt. Bailey redesigned the valve gear so that the steam would follow full stroke and also reduced the area of the ports to about 3 percent. When this change was made the old engine-driven pumps worked as nicely as anybody would wish, as I can testify from personal experience after a cruise with them. As you will see from this story there was no high science or thermodynamics in this, but the application of good common sense to a difficult problem.

As bearing on this question, I want to emphasize the importance of careful observation and of checking up observations at the time they are made, so as to be sure of their accuracy. If the data are accurate they can be worked up at any time by anybody, but very often there is no other chance to get them accurately than at the particular time they are taken, which makes it of the greatest importance that their accuracy should be assured. Frequently there are very simple checks which enable this to be done. For example, in a test of a steam boiler which is intended to be run uniformly for 24 hours or more the hourly figures should not differ greatly. Two of the most important points are the amount of water fed to the boiler and the amount of coal burned. It is quite common to lay out a diagram where the ordinates for each hour will represent the total amount of coal and of water up to that time. If the amount used each hour is constant the curve joining these points would be a straight line. Now if, at the end of any hour, when the point is put down and the curve extended, it is found that there is a marked deviation, there would be a chance to hunt for the trouble, and either correct the figures if they are wrong or see what, if anything, has occurred in the conditions.

Another case illustrates in a simple way the exercise of common sense and may be worth telling. Years ago, in the navy, eccentric straps were always made of brass, and most naval men were familiar with that practice only. In the merchant service, however, the practice had already come into vogue of making the strap of cast steel, or even cast iron, and lining it with white metal to make the rubbing surface softer than the eccentric itself. The eccentric strap of a steam launch engine broke, and the young officer who had charge of that work tried to repair it by taking a couple of pieces of sheet brass of the proper thickness and riveting them together and then bending them over to make a lug for bolting to the other half of the strap. As might be expected, however, as soon as any load came on this it broke at the bend. Another young officer on this ship happened to know of the merchant service practice, and he made the repair by having the blacksmith take a piece of half-inch square bar-iron and forge it to the proper shape, and then used one of these pieces of brass as a liner. This gave entire satisfaction. The point to be noted is that he was not able to copy the exact apparatus of the merchant service, but he had grasped the general principle, which was that the body of the strap should be of a material to give strength, with a facing of a softer metal.

The Draftsman in Shipbuilding*

BY S. C. JENKINS

The building of ships is probably the most interesting and complex of any branch of engineering. There is no living man who understands in detail all the professions which enter into the design, construction and operation of a modern battleship or merchant vessel. Some men who hold high positions in the shipbuilding world may think this a bold statement, but it is true. Because of this fact we have naval architects, marine engineers, electrical engineers, navigators, etc., each specializing in his branch of the profession.

When America's ships were the peers of any afloat—that is, before the Civil War—the draftsman was unknown so far as ships were concerned. It is true that the steam engine had made its appearance by then, and that draftsmen were necessary for that branch of engineering, but they were probably known as mechanical engineers, though their knowledge was far more limited than the draftsman's knowledge of the present day. The ships of that day were built by the men who afterward manned them; were rigged by their captains, mates and sailors. Even at this day you can see this method of building certain types of ships in old New England towns where draftsmen are not needed or desired.

Before 1890, the problems of ship construction were far less complicated than at the present day. The foreman of each department worked out his problems after the skeleton ship was framed up; but in those days the requirements of the owners did not include the multitude of mechanical and electrical innovations which were then untried and barely known, and interferences were overcome by ripping out work and rearranging it to clear. The elements of time and cost were secondary. The whole scheme was crude as we see it now, but in spite of all this the results show evidence of capable work. Shipbuilding was then an art and the ship carpenters, the riggers, the joiners, were artists.

To-day what do we find? The art of shipbuilding is, unfortunately, fast fading away, and a shipyard of the present day is a manufacturing plant. There is a foreman for every branch of the work, but he is a master mechanic. He does what he is told. And what tells him? Blueprints of plans which have been developed by men who are not ship carpenters or riggers, or plumbers, or ship fitters, or blacksmiths or machinists, or pattern makers, or joiners, or electricians. Who, then, are these men? Are they the managers, superintendents, naval architects, marine or electrical engineers? No! They are simply draftsmen. These men who have to

* A paper read before the local Association of Marine Draftsmen at Norfolk, Va.

design and develop the problems of ship construction, many who devote their lives to the complex and intricate study of the various trades that their work may be correct, progressive and economical, are merely draftsmen. They must make the structure strong enough, make room for everything, provide a place for everything required in the specifications, order it, make it all fit and furnish it to the yard at the right time so the whole structure may be assembled in accordance with a prearranged schedule. They must understand the fundamental principles of all the trades, must be well versed in the scientific branches of naval architecture and mechanics, understand the methods of operation and navigation to a sufficient degree to develop a machine which will be superior to anything yet built; but they are only draftsmen.

Because of the advances made in machinery for construction purposes which enable tons of material to be worked, where pounds were worked before, ships can be built in a fraction of the time it used to take. But with this enormous output of material comes the necessity for information to correctly put his work through the various shops without waste or loss of time. The joiner bulkheads are sometimes made before the keel is laid. The rigging and its endless fittings are all ready long before the masts are stepped. The whole mass of structure is lying in heaps before the shipways, punched, planed, sections riveted all ready to assemble. Oftentimes we see auxiliary machinery foundations waiting for the various machines a month before they are attached in place.

Has the ship draftsmen made this modern method of shipbuilding possible, or has this modern method made the ship draftsmen possible? Let us see. Ten years ago a battleship of that period of 14,000 tons was built in four years. To-day a modern battleship three times as complicated and twice the displacement is built in 33 months. Merchant vessels are built in a third less time and commercially are a superior product, although their beauty is less and less apparent and unnecessarily so. Why is this development and to whom is the credit due? I will answer that in a large measure it is due to the draftsmen in the shipbuilding profession. I admit that the yard organization and the sub-contract and piecework systems have made it possible to reduce the cost of ship construction, but these systems are made possible by the draftsmen, and in a measure it has entered into the time element, but the progress in ship construction both in design and time is primarily the result of the development and experience of the drafting organization.

The plans the draftsman gives to the yard are the result of deep thought, careful study, and good judgment. If the plan is faulty and the work built to a faulty plan is criticised, he is condemned. But if everything fits, if he has ordered his material with small waste, if his designs are praised by the owners, who gets the credit for it? Very seldom does the draftsmen share the honors; that is all given to those who come in contact with the owners, and they seldom pass it to those whose brains produced the ideas and thereby made them possible.

Take, for example, the cargo-handling facilities of a modern cargo carrier. This problem in itself is a study to which some men outside the drafting profession are devoting a great share of their time. It is one which vitally determines a successful ship from the owner's standpoint. The owner wants to get his cargo in and out of his ship within the smallest possible time. He wants to handle it with the minimum amount of damage, and he don't want to renew his running gear every trip. These facts the draftsman understands and his whole effort is to produce these results. After his structure is developed and ordered and long before the keel is laid his thoughts are centered on this new problem, radically different, yet a part of this great creation. He reads what magazines he can afford to buy, not in the office, for he must draw there, but at home—if he be so fortunate as to have one. He obtains from available sources plans of the ships which have similar cargo arrangements; he spends his vacation sometimes studying other ships and other yards, and his work is constantly on his mind. Few men interested in their work will forget it when they leave the office. They will continue to study and converse on their problems long after they have covered their boards. In this work on this cargo gear the draftsmen will make every effort to have every bolt fit in every hole; will study hour after hour how to keep leads straight to avoid friction and unnecessary blocks and sheaves; how and where to provide a swivel block or a fountain block or fair leaders to avoid chafing a rope. He must go into the calculations of stresses and strains and see that a boom designed to lift 50 tons will do it with safety and that the whole gear will be designed in proportion. He will provide bolsters at the hatches; will locate pad eyes and deck eyes at convenient locations for properly handling the special cargo for which the ship is designed, and he will use his best efforts to prevent any two leads from fouling. Many are the ideas which come before him in his study of the design, and he uses his best judgment as to which he shall develop. And all the while is the necessity to hurry. He knows just when each element in the building of the ship will be ready for his work, and he must not be the cause for delay by not having the plans done in ample time to get the finished product ready for the ship when it is due.

Twenty years ago there were scarcely any ship draftsmen in this country. The White Squadron started a new era in shipbuilding in this country and draftsmen had to be imported. The colleges noted this and began courses in naval architecture. As would be supposed, there were many incompetent men who came to this country at that time, and it was most unusual for the men who began the plans of a ship to stay with the yard until the ship was finished and see the result of their work. As soon as their work reached the yard they left, and many men to-day remember the trouble that often followed when the work was put on the ships. To-day there are many men of fifteen years' experience in the design and construction of ships: men of ability who are progressive, studious, ambitious and energetic; who invite criticism and investigate new ideas. It is because of these men that this article is written. Their importance in shipbuilding is not appreciated, and little thought is given by the shipyard officials for their welfare.

Ship draftsmen are not mechanics. They work with their brains, not with lead pencils and drawing ink. The shipyards do not get the best there is out of them because they do not treat them as professional men, but as tradesmen. Drafting is not a trade; it is a gift, and many gifted draftsmen have left the business because of the lack of opportunity which shipyards offer. At some shipyards in this country a draftsman is apparently considered a machine to make so may lineal feet of lines on tracing cloth a day, a mistake which often increases the cost of a completed ship and makes her less successful as a money earner than if more thought and less lines were required of him.

Some small yards have a library for the use of the draftsmen, but I know of none of the larger yards which has this, yet the large yard is the one that needs most to furnish the draftsmen with information. Every ship built has new problems which are different from any other ships, and it is the draftsman who has to puzzle these problems out. The result is he has to devote his hours of freedom to fortify himself with each new day's demand because, as was before stated, he has to make lines while in the office.

Another thing in which the shipyards are unjust is in the matter of trial trips. The ordinary draftsman cannot afford, on his meagre wage of $4.50 (18/9) or $5 (1/0/10) a day to

take trips on ocean-going ships to study his work. It should be the duty of the yard officials to invite him on the trials so he can see the defects he has made if there are any, or to enjoy the success of his efforts if he has been successful. This will increase his efficiency and make him more valuable to the firm he is employed by and to the shipbuilding world at large. This is another point where the small yards of to-day are more progressive. In the larger yards of to-day a draftsman is indebted the rest of his life almost to his superior officer to be allowed the privilege of accompanying a ship, even if he is given some menial work to prevent his being idle for a whole day.

Let us see what some of the problems are which confront a first-class ship draftsman—problems which he actually has to work out himself and which he is actually responsible for. Let us assume in preparing this list, which incidentally will be incomplete, that the owners have furnished a small sketch of the ship they wish built, generally an impossible design for reasons so numerous it is impossible to state them in this article. Suffice it to state that owners usually want what is structurally impossible to obtain and spaces allotted to machinery and living quarters are so small that much time is required after a contract is obtained to arrange them in a workable design. The contract is usually signed before any preliminary work is begun in the drafting offices; in fact, before the drafting force has even seen the plans. Ten months from date the ship must be delivered to the owners complete, ready for use, etc., under penalty of $200 (41/13/4) per day perhaps, and in rare intervals with a bonus of the same amount for delivery before that date. The ship is built to the rules of some shipping bureau or register, and also to specifications. Material must be ordered at once. Plans must be provided for the yard. There is a scramble of engine draftsmen for the structure in the machinery space, and the whole drafting force is keyed up to a high pitch and nerve-racking tension to satisfy all comers.

The structure is begun. One good man who can think quickly, anticipate wisely, and is accurate, is given the midship section, another the keel, still others the framing, shell, decks, stem, stern, frame and rudder, and the new creature, which in seven months will be afloat on the water, has started. Each man must be capable of handling any problem, every little angle or plate must show the same on every plan if it shows at all, the riveting must all agree, else there is trouble when it goes together in the yard.

Before these plans are well along the plates, and shapes must be ordered without waste yet sufficiently large to be worked, usually a half inch on a plate and two inches on a shape, because the mills will not guarantee to furnish them closer. This will not allow of scaling, for with the plans on one-fourth-inch scale the error would be considerable, hence they must be figured. The pillars and girders are then taken in hand, taking care to support the structure, to keep clear of any possible interference with handling the cargo, to prevent undue vibration in the ship, yet always mindful to save material.

While all this is going on, another man is arranging all this work on a plan, a joiner plan, assembling the work, let us say, and providing a place for all that is required in the specifications, arranging and rearranging the berths and lockers for the crew in a space only half large enough. Still others are calculating the strains and stresses of the hull, to be sure she will stand any stress of weather she may be liable to encounter, to discover if her weights are so located that she will trim right fore and aft and athwartship; to see that she will not turn over either light or loaded, and to see if she will carry the cargo required of her by the specifications. Her cargo-handling gear, her boat stowage, ventilation, scuppers, her multitude of fittings too numerous to mention in an article of this scope, even to the rivets, must all be designed and ordered before the yard can take this work in hand; and if she be built for the passenger trade the interior design with all its complications must be studied and carefully worked out to a successful and artistic finish.

This is barely an outline of what the duties of a shipdraftsman are, yet it is perhaps enough to show the high officials of the large shipyards that they are underestimating the value of these faithful servants in their employ and are not providing proper compensation for what they demand.

Fifteen years ago there were not enough draftsmen of experience in the whole country to plan the work now required by one yard. For that reason the building of ships was slow. By reason of the capabilities of the draftsman of to-day and the fact that he can now fill the yard with material two months after a contract is signed, ships are being built three times as complicated, twice the size in one-third less time, and as the organization of the drafting room is developed the time will be reduced.

It is up to the shipyard officials to assist in this development. The element of co-operation is one of the highest essentials, and if they will offer reasonable inducements the ship draftsman will do his duty, for he loves his work. If he did not, he would long since have left the business, for its returns are at present out of all proportion to its demands.

This article, as you notice, has dealt simply with the draftsman in his work on the merchant hull. The problems which the engine draftsman has to deal with and the draftsman of warship construction are equally difficult perhaps, and the poor government draftsmen have difficulties which would require a separate article to discuss.

However, from a charitable standpoint, let us try to believe that the development in shipbuilding has been too rapid and that the shipyard officials will in time devote some thought to the possibilities of their plants through intelligent consideration of the drafting organization where, by a progressive system of advancement for capable men, they will encourage the draftsman instead of killing his ambition through careless indifference as to his welfare and the idea that he is a necessary evil.

A 45-Foot Motor Cruising Yacht

A full-powered cruiser has just been constructed by John I. Thornycroft & Company, Ltd., for service in the Near East. The vessel was required to possess first-class sea-going qualities, and she has been built 45 feet in length, with 9 feet beam and an extreme draft of 2 feet 9 inches. The propelling equipment consists of a Thornycroft M6 type motor, complete with Thornycroft reverse gear and clutch, using kerosene (paraffin) as fuel, and starting directly on gasoline (petrol). The engine has six cylinders, each 4½ inches in diameter and 6 inches stroke, developing 45 brake-horsepower. The boat has attained a speed of 9.7 knots over the measured course, using kerosene (paraffin) as fuel.

The hull is built of teak on frames of American elm, the keel is also of American elm. The hull to 3 inches above waterline is sheathed with copper. In the fore peak a 100-gallon fuel tank is stored, and a chain locker is arranged above it. The accommodation comprises, forward, a sleeping cabin, ventilated by two cowl ventilators. A ladder and hatch provide access to the upper deck. Aft of this is a very roomy saloon, ventilated by an overhead skylight, and divided from the sleeping cabin by curtains. Following this is the toilet room, and on the port side a well-arranged pantry. Aft of this again is the motor room, containing the engine and reversing gear, two folding cots for crew, cooking stove, freshwater tanks and tool lockers, etc. The engine case is built with a flat tray top to serve as a table.

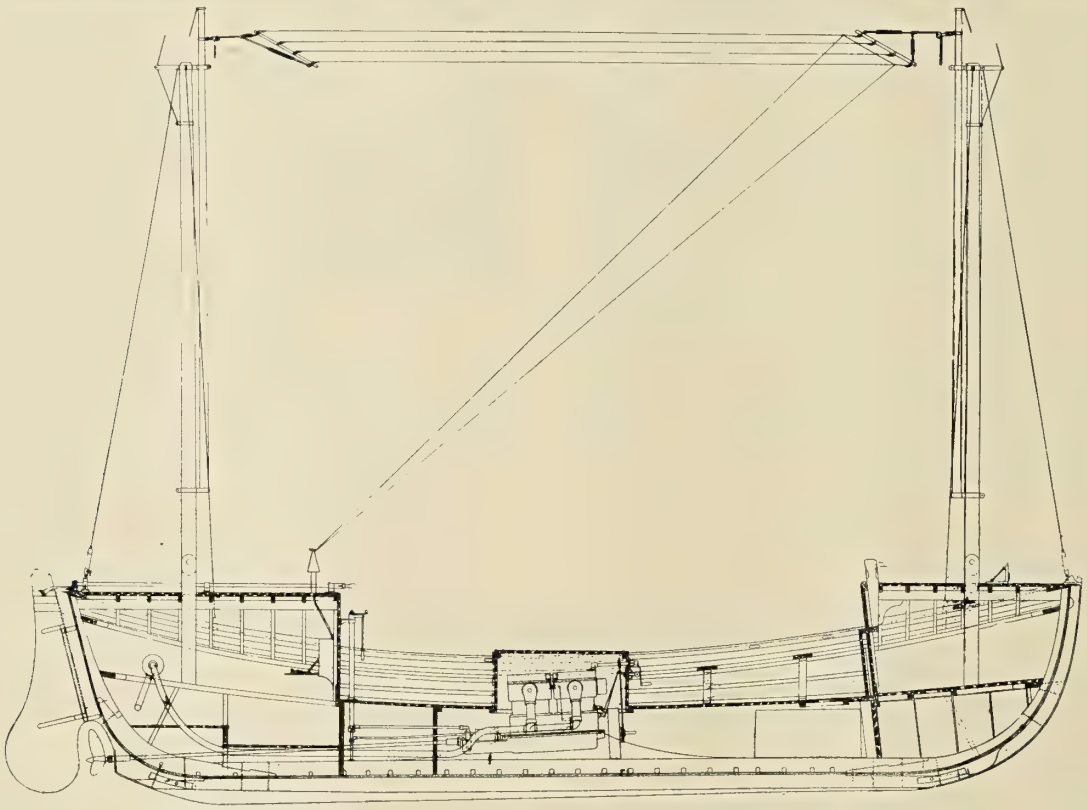
Design for a Motor Life Boat

The strongest count against the shipbuilders and shipowners of the day is that they have neglected the small boat in the wonderful improvements instituted in practically every other direction on shipboard. Not only as regards davits, but the boats themselves have shown little or no modernization. Worst of all, the small power boat has been ignored by steamship owners, in the face of its remarkable development by manufacturers. The power boat both in the United States and in Europe has reached a high state of perfection. American marine engines are bought in large quantities to-day in every part of the world. The navies of the world use power boats very largely. The gas engine for automobile and motor boat uses is one of the engineering triumphs of the present age. Yet few passenger steamers are equipped with even one power boat for use in times of great danger or sudden emergency. It takes but little stretch of the imagination to see what valiant work two or three strong motor boats could have done in a disaster such as overtook the *Titanic* in picking up some of those in the water and in transferring them to those life boats which were not filled. The motor boat could then have easily towed all of the survivors to the nearby *California*. In the case of the *Republic*, which sank about two years ago, after collision with the *Florida*, hour after hour was consumed in transferring passengers of the *Republic* to the rescue ship. Fortunately, calm weather prevailed. How much more quickly the work could have been done had there been at least one power boat to tow the life boats to and fro!

Any modern cruiser or battleship is equipped with a large number of motor boats, and they are invaluable to these vessels. A very potent reason for the mercantile marine to make greater use of the motor boat lies in the fact that under modern conditions it is well-nigh impossible to man the life boats of a huge passenger steamer properly. The seaman of to-day on the passenger steamer is little better than a longshoreman. He is not trained in the use of oars and has no experience as a boatman; whereas, one man can operate the marine engine. A handful of picked men would be of more use, were motor boats carried, than many inexperienced oarsmen. Furthermore, owing to the introduction of the automobile and the large number of power boats used for pleasure, on any passenger steamer a considerable number of people who are expert in handling a gas engine could be found.

The life-saving service in the United States and that in many foreign countries have very generally adopted the power life boat. The same features which make it far superior to the oar-propelled boat in this service should cause one or more to be carried on all large vessels. In a heavy seaway the ordinary life boat is in constant danger of sinking because of the inability of the oarsmen to keep the boat from being thrown broadside into the trough of the seas.

Such a power life boat as shown in the accompanying plans can be kept by one man head on to the waves and will also tow a number of life boats astern. This power life boat is non-sinkable and self-righting. It is designed to live through the worst storms. Its heavy duty Standard engine has been designed and developed to meet most fully the conditions. Unusual power is obtained at a low rotative speed, so that a large slow-turning propeller is swung, giving the boat great towing capacity. The engine installed shows the center of gravity to be unusually low. This feature is important in a small boat, as all weights are kept as low as possible for the greatest stability. It will be seen that the engine is housed in a water-tight compartment and that all controls are carried outside, so that the engine may be started, stopped and reversed without opening this compartment. Complete control of the boat is had at the tiller, as the controls for the throttle and the reverse gear and clutch are carried aft to where the steersman stands. Water, gasoline (petrol) and other supplies may be carried behind the fore and aft water-tight bulkheads below the floor. The boat's masts when extended are 35 feet high. These telescope and fold down. This operation is performed very simply and easily. Each



A NON-SINKABLE AND SELF-RIGHTING MOTOR LIFEBOAT EQUIPPED WITH WIRELESS

is raised by a single halyard, which in raising the mast also tightens the stays.

Perhaps what will seem most novel in this boat is her wireless equipment. Similar apparatus, however, has been installed in small boats before this. The Austrian Lloyd Steam Navigation Company equipped a life boat with a Standard engine and wireless equipment two years ago, just after the accident to the *Republic* and *Florida*. The boat here shown with an aerial of about 35 feet and spread of about 25 has a sending radius of about 75 miles. Messages could be received from a distance of from 500 to 800 miles.

One can readily see the possibilities in a boat so equipped. One or two such power boats in time of a wreck, besides picking up those in the water and seeing that all life boats were equally loaded, could keep a large fleet together. Each could tow six life boats at a speed of from three to four miles per hour. They could in this way keep the survivors from becoming scattered until such time as some ship could be communicated with and help obtained.

Electric Trucks for Steamship Terminals

BY F. H. HAINES

An electric freight truck which has a maximum capacity of 2,000 pounds and a bulk capacity of six hand truck loads per truck is now in practical operation at several large railroad and steamship terminals at Jersey City, N. J., New York, N. Y., and Savannah, Ga., where it is said to be giving excellent results. It is claimed that the trucks are producing a saving of from 15 to 35 percent in the cost of handling freight, besides facilitating the maintenance of steamship schedules.

Any unskilled laborer can operate the truck at a speed of from 2 to ten miles per hour, for a ten-hour day on one charge of electricity, at a cost of 10 cents (0/5) per day per truck for current. The frame consists of two I sections,

LOADS OF 1,890 POUNDS BEING TRANSPORTED OVER 65 PERCENT GRADES BY ELECTRIC TRUCKS AND OTIS INCLINED ELEVATOR

which extend the entire length of the platform, and is supported by four spiral springs. The wheels are equipped with solid rubber tires, giving the body additional elasticity. The power is derived from a single storage battery, consisting of two sets of 12 cells each, the capacity of which is 120 ampere hours at 60 volts. Power is taken from the batteries through a maximum capacity fuse and circuit breaker and a drum type controller, the latter being mounted in ball bearings between the two frame members, and is connected to a set of resistance, and is operated by a vertical lever moving in a vertical plane within convenient reach of the operator's left hand, through an arc of about 120 degrees, giving five speeds forward and five reverse. However, power cannot be sent into the controller unless the foot pedal, which simultaneously releases the band brake on the jack shaft and throws in the circuit breaker, has been pushed down. The lever to the left is the controller; that to the right the steering lever; and the pedal just above the foot board, or operator's stand, the brake. To increase the bulk carrying capacity, one end is equipped with a hinged iron gate, which may be lowered, allowing 2½ feet additional loading surface.

DIRECT TRANSHIPMENT FROM SHIP TO CARS BY ELECTRIC TRUCKS

Freight is conveyed by the trucks direct from the ship's hatches, through the cargo ports, and over the drop platforms to the pier or into the cars, and vice versa. One electric truck with one operator will carry a load of 2,500 pounds up 20 to 35 percent grades, while it would require eight hand trucks and two to four additional helpers for each truck to carry the same load and negotiate the same grade. The electric truck is also successfully operated in connection with the inclined elevator which is used to convey ordinary hand trucks and their loads over heavy grades brought about by changing tide conditions.

A sling load of 16 bags of grain is hoisted from the hold of a coastwise steamship by the hoisting engine to the discharging deck, where it would have to be distributed to 5 hand trucks carrying 3 bags each, while the entire sling load can be placed on one electric truck direct from the hoister and sent to its destination on the pier or into the cars.

The handling of canned goods and other small package freight from the lower decks to the discharging decks is done by the use of flat boards, containing ring bolts at each end through which rope slings are run and connected to the hoister pennant or fall. This flat board will contain 43 cases of canned goods, weighing 60 pounds each, and is landed directly on the electric truck for discharging to the pier, the flat board being returned to the ship with the empty truck for another load. In discharging the same number of cases by hand trucks, it would require 8 trucks.

The average hand truck speed is about 1½ miles per hour, including loading and discharging, while the electric truck will maintain a speed of 2¼ miles per hour, including loading and discharging, without tiring, as is the case with manual labor; however, the additional time required to load and discharge the electric truck materially reduces the round trip speed, but the saving is brought about by the increased capacity and speed of the electric truck.

There are various kinds of mechanical devices for transferring package freight at railroad terminals having no steamer line connections, and also for transatlantic lines with or without direct rail connections. Many methods have proved practical in this direction, as the freight on railroad terminals is only conveyed to or from the car doors, then dumped, while in the latter case it is hoisted to or from the overall hatches of ships which do not contain side cargo ports, and is placed either on the pier or in the ship. It is, therefore, evident that, in order to mechanically convey freight in this manner through side cargo ports, with which coastwise steamships are equipped, it would be necessary to equip the ship, as well as the pier, with conveying machinery, which is not practical. Therefore the practical utility of the electric truck for service at coastwise steamship terminals, as outlined in the instances just described, is evident.

Shallow Draft Ferry Driven by Gasoline (Petrol) Engines

Except where small boats are used as passenger ferries internal-combustion engines have seldom been utilized for the propelling machinery of this type of craft. A new departure in this direction, however, has been made recently in the construction of the steel car ferry *Henderson,* designed to carry a load of two 50-foot interurban trolley cars, each weighing 87,000 pounds, across the Ohio River at Evansville, Ind., on a draft of about 3 feet. The boat was designed by Morris M. Whitaker, Nyack, N. Y., and built by the Dubuque Boat & Boiler Works, Dubuque, Ia. The distance over which the ferry runs varies from ½ to 1 mile, according to the stage of the river. The schedule of the ferry requires hourly trips each way, the time of crossing varying from six to fifteen minutes, according to the direction of the passage and the stage of the river.

Both the construction of the hull and the arrangement of the propelling and auxiliary machinery are of special interest, because both are unusual. The main particulars of the hull are shown in the general arrangement plans, shown in Figs. 3 and 4, and the complete scantlings are shown in the midship section, Fig. 2. To carry such a heavy load on such a light draft without interfering with the machinery arrangements furnishes a problem which a naval architect seldom meets, and provisions for the strength of the hull in this instance

FIG. 1.—SIDE-WHEEL CAR FERRY HENDERSON DRIVEN BY GASOLINE (PETROL) ENGINES

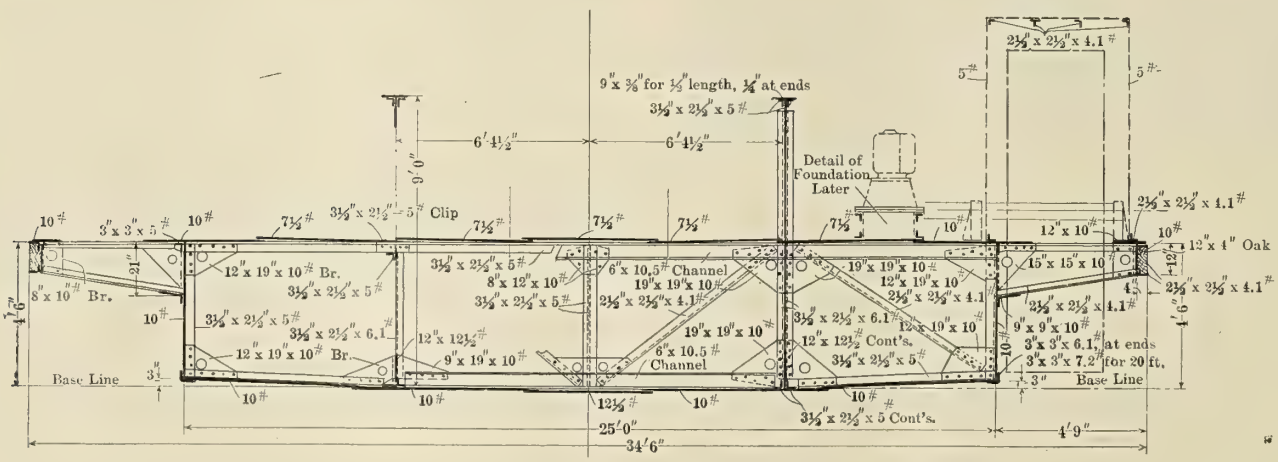


FIG. 2.—MIDSHIP SECTION

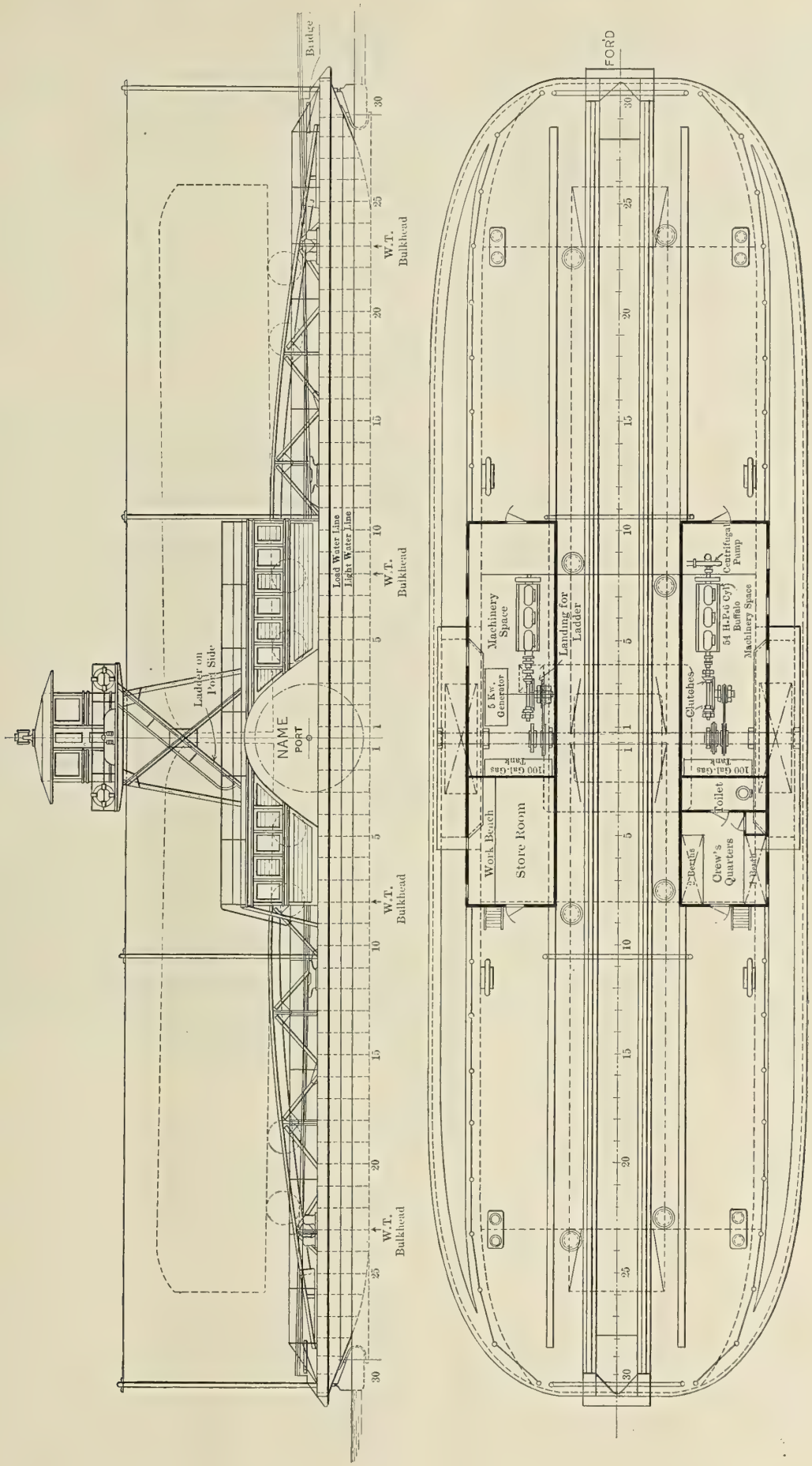


FIG. 3.—GENERAL ARRANGEMENT PLANS OF CAR FERRY

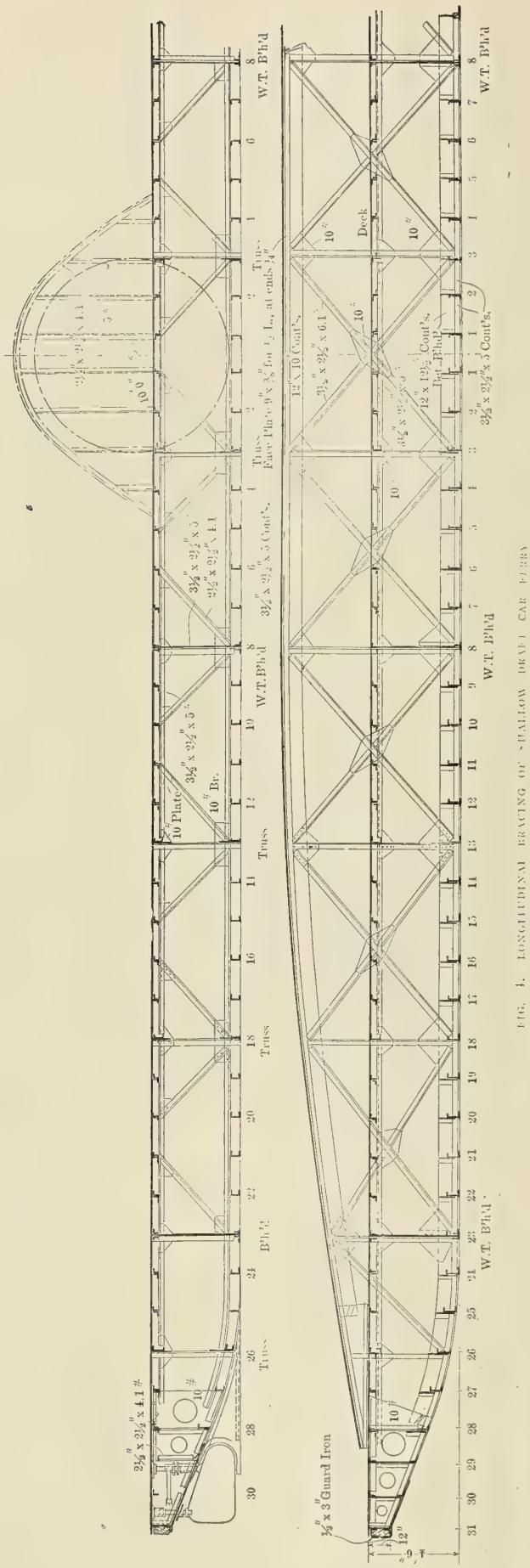


FIG. 4. LONGITUDINAL BRACING OF SHALLOW DRAFT CAR FERRY

are excellently carried out and the machinery arrangement has proved as flexible and reliable as the old-time steam machinery. The boat is 120 feet 8 inches long over all, 120 feet molded length, 25 feet beam molded, 34 feet 6 inches beam over guards and 4 feet 6 inches depth of hold.

Propulsion is by side paddle-wheels. The wheels are independent, although there is a cross-over shaft by which both paddle-wheels can be locked together and driven from one engine. The wheels are 10 feet in diameter with a 3-foot face. Each wheel has ten buckets, 18 inches wide, and the designed speed of the wheels is forty revolutions per minute.

The main engines consist of two six-cylinder, four-cycle, 7-inch by 9-inch Buffalo gasoline (petrol) engines of 54 horsepower each, located in separate engine rooms and operating the wheels independently by means of double clutches and cut steel bevel gears. The motors have double ignition, a Bosch high-tension and Atwater-Kent distributor. The reduction in speed from the motors to the wheels is 10 to 1,

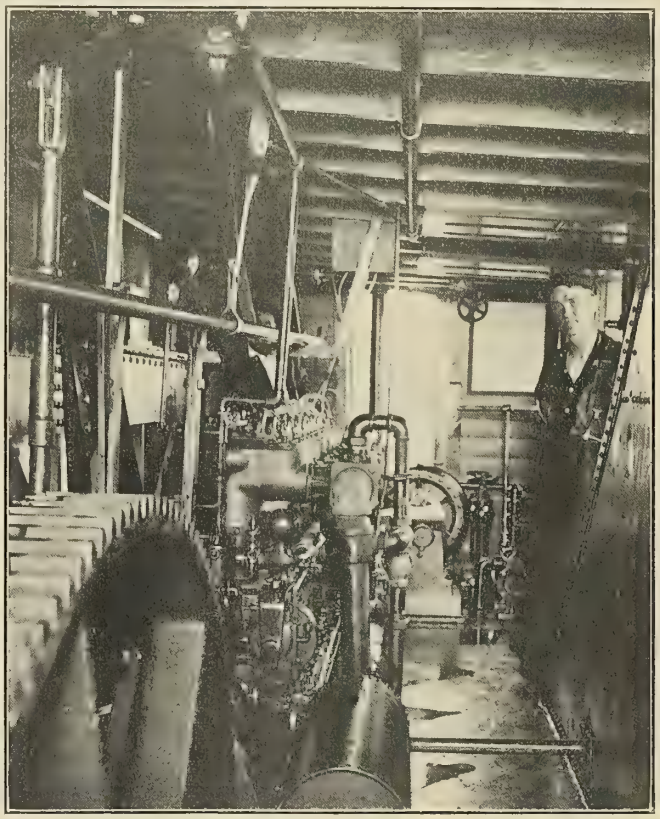


FIG. 5.—ONE OF THE ENGINE ROOMS

and by means of the double clutches (one of which gives motion in one direction, and the other in the opposite direction) perfect control of the wheels is obtained.

There is an independent electric light outfit, supplied by Carlisle & Finch, operating at 550 volts, to supply current for a searchlight and for lighting the trolley cars when on the boat as well as for lighting the boat itself.

Bilge and air pumps are attached to each motor. A large centrifugal fire and bilge pump is worked through a clutch from one of the main motors by means of a silent chain. This pump, which is furnished by the Morris Machine Works, is connected to each watertight compartment on the suction side, and also overboard, so that it can discharge over side or through two hose pipes for fire purposes. It is capable of throwing a 1¼-inch stream under pressure of 150 pounds per square inch at the nozzle.

Lifeboats and other equipment are provided as required by the United States Steamboat Inspection Service.

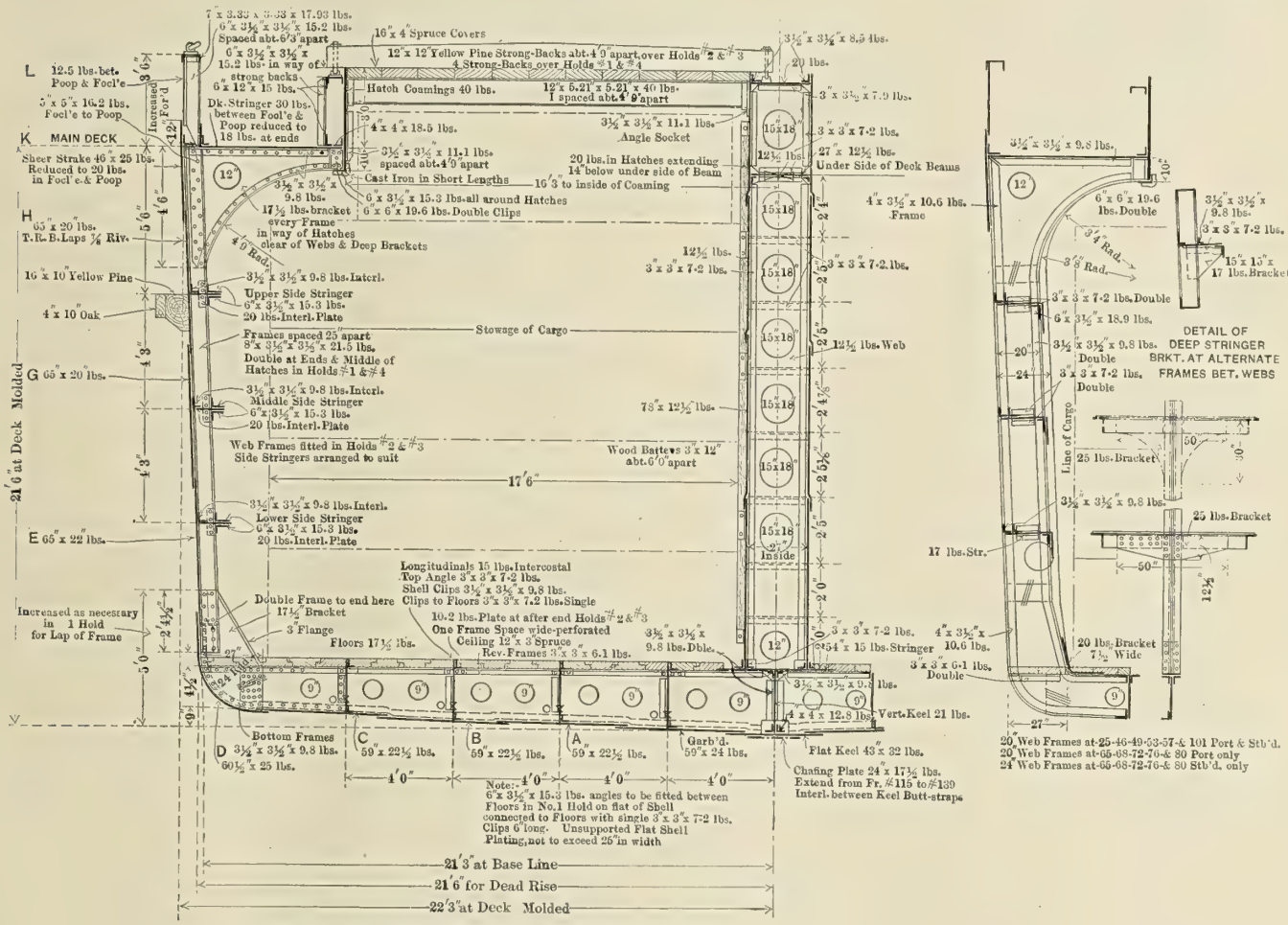
Lumber Steamship for the C. A. Smith Lumber Company

The Newport News Shipbuilding & Dry Dock Company is now building at its works in Newport News, Va., a steam lumber-carrying vessel, the construction of which embodies several novel features. The vessel has been designed by Edward S. Hough, of San Francisco, for the special service of the C. A. Smith Lumber Company on the Pacific Coast, and will be named *Adeline Smith*. Its principal dimensions are as follows:

Length over all	310 feet 6 inches.
Length on waterline	296 feet 8 inches.
Beam, molded, at main deck	44 feet 6 inches.
Depth, molded	21 feet 6 inches.

The principal feature of the design is the adoption of Hough's patent center-trunk construction, which is claimed in lumber-carrying vessels, which are, as a rule, very beamy and comparatively shallow, and have their deck cut away by hatches to such an extent that in the ordinary type of construction structural weakness often develops in the larger vessels, and as they also carry very high deck loads, and nearly all use fuel oil, which is carried in the ordinary type of double bottom, the free surface in the tanks often makes them tender.

Another feature of the design of the vessel is the extent of the cargo hatches, there being four on each side of the center trunk. The hatches are especially arranged to take care of the standard lumber units which have been adopted by the C. A. Smith Company. To suit these units and provide maximum stowage, the main deck is built without either camber or sheer.


MAIN DECK
Stowage of Cargo
Hatch Coamings 40 lbs.
Cast Iron in Short Lengths
Wood Battens 3"x 12" abt. 6'0" apart
Bottom Frames
Flat Keel 43" x 32 lbs.
Vert. Keel 21 lbs.
Garb'd.
Inside
Frame
Under Side of Deck Beams
Angle Socket
Double Frame to end here
Floors 17½ lbs.
Note:- 4'0"
Chafing Plate 24" x 17½ lbs.
Extend from Fr. #115 to #130
Interl. between Keel Butt-straps
21'3" at Base Line
21'6" for Dead Rise
22'3" at Deck Molded
DETAIL OF DEEP STRINGER BRKT. AT ALTERNATE FRAMES BET. WEBS
Line of Cargo
25 lbs. Bracket
17 lbs. Str.
20 lbs. Bracket 7½ Wide
20 Web Frames at-25-46-49-53-57-& 101 Port & Stb'd.
20 Web Frames at-65-68-72-76-& 80 Port only
24 Web Frames at-65-68-72-76-& 80 Stb'd. only

SECTION SHOWING CONSTRUCTION IN CARGO SPACE
BULKHEAD No. 18 TO No. 107
LOOKING FOR'D.

FIG. 1

to be especially adapted to lumber-carrying vessels. As shown on the midship section this construction consists of a narrow trunk extending from the top of the floors to the deck, dividing the hold longitudinally. This trunk extends the full length of the cargo hold, and is used for carrying fuel, oil or water ballast, as desired. It is claimed for this construction that the center trunk, acting as a girder, greatly increases the longitudinal strength, and that, being deep and narrow, the free surface of oil is reduced to a minimum, and greater stability thus obtained. These points are especially important

As indicated on the accompanying plans the vessel will have a single deck, a raised forecastle and full poop, with two tiers of deck houses above the latter. The machinery will be located in the stern, and the pilot house and navigating bridge will be aft also, so that the deck will be entirely unobstructed between the forecastle and poop, and thus available for deck cargo. There will be a double bottom of the cellular type under the machinery space for carrying fresh water.

As cargo is generally carried only one way the vessel will usually go north in ballast, and as heavy seas are to be

encountered on that trip it is necessary to carry sufficient water ballast to put the vessel well down at the head. For this purpose the hold is subdivided into four compartments on each side, and compartments No. 2 and No. 3 are arranged to act as deep tanks. In these holds deep web frames are fitted to stiffen the sides, and the hatch covers are provided with special strong backs. For handling this water ballast there will be located in the engine room a De Laval steam turbine-driven centrifugal pump with a capacity of 3,500 gallons per minute.

Accommodations for the officers and crew will be very complete; those for the crew located forward and all other quarters aft. Special accommodations will also be provided for the owners, consisting of private dining room, lounge, three staterooms and two baths. All quarters will be heated by steam and lighted by electricity.

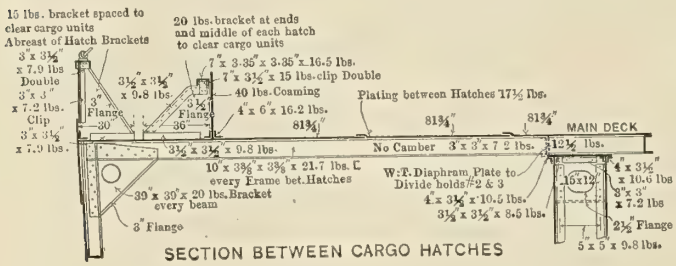

15 lbs. bracket spaced to clear cargo units Abreast of Hatch Brackets
3"x 3½" x 7.9 lbs Double
3"x 3" x 7.2 lbs. Clip
3"x 3½" x 7.9 lbs.
20 lbs. bracket at ends and middle of each batch to clear cargo units
7"x 3.35"x 3.35"x 16.5 lbs.
7"x 3½"x 15 lbs. clip Double
40 lbs. Coaming
Plating between Hatches 17½ lbs.
3½"x 3½" x 9.8 lbs.
3" Flange
4"x 6"x 16.2 lbs.
81¾"
MAIN DECK
No Camber 3"x 3"x 7.2 lbs.
12½ lbs.
3½"x 3½" x 9.8 lbs.
10"x 3⅜"x 3⅜"x 21.7 lbs. @ every Frame bet. Hatches
W.T. Diaphram Plate to Divide holds #2 & 3
4"x 3½"x 10.5 lbs.
3½"x 3½"x 8.5 lbs.
39"x 30"x 20 lbs. Bracket every beam
15x12
4"x 3½" x 10.6 lbs
3"x 3" x 7.2 lbs
2½" Flange
5"x 5"x 9.8 lbs.
SECTION BETWEEN CARGO HATCHES

FIG. 2

For deck machinery there will be a steam windlass and two steam capstans on the forecastle deck, and two steam capstans on the poop. Combined steam and hand steering gear will be fitted, with the steering engine located at the forward end of the engine casing. As special gear for handling the lumber is located at the terminals, the only cargo-handling gear on the vessel will consist of two booms on the foremast. One 8-inch by 8-inch double cylinder, double drum steam winch will be fitted on an extension of the forecastle deck for working these booms. An electric plant with two 10-kilowatt, turbine-driven, direct-connected generating sets will be located on a flat in the engine room. There will be two 14-inch searchlights on the flying bridge, and the vessel will have a wireless telegraph outfit. In the engine room there will be a workshop, with power-driven lathe, drill press and emery wheels.

The propelling machinery will consist of a triple-expansion engine, with cylinders 21 inches, 35 inches and 60 inches diameter, respectively, having a common stroke of 42 inches. There are four Babcock & Wilcox boilers. The engine will have piston valves on the high and intermediate cylinders, and a double-ported slide valve on the low-pressure. All valves will be operated by Stephenson link motion. Steam reversing gear of the direct-acting type will be fitted. There will be a separate cylindrical surface condenser with cast iron shell. The circulating pump will be of the centrifugal type, driven by a single cylinder vertical engine. An air pump of the Edwards type and two bilge pumps will be driven from the high-pressure cross-head; all other pumps will be independent. An evaporator of 2,500 gallons capacity per day will be provided.

The four main boilers will have a combined heating surface of 7,200 square feet, and will be arranged with a fore-and-aft room. They will be fitted to burn fuel oil with mechanical atomization, using burners of the Newport News Shipbuilding & Dry Dock Company's own make and type, which have been developed from an extended series of tests in the builders' fuel-oil experimental plant. A vertical donkey boiler will also be fitted.

Launch from the Harbor Dockyard

On March 5, Messrs. Irvine's Ship Building & Dry Docks Company, Ltd., launched from their harbor dockyard the handsomely modeled steel screw steamer *Start Point*, built to the order of Messrs. Furness Withy & Company, Ltd., for their Point Line. The dimensions of the vessel are 390 feet by 50 feet by 27 feet depth, molded, carrying over 7,000 tons on a light draft. She is built to British Corporation classification, having three complete steel decks, with cellular double bottom and fore and after peak tanks for water ballast. The vessel is constructed with deep sectional frames, and is divided into seven watertight compartments by means of six watertight bulkheads. Four large hatches are provided and a cross-bunker hatch amidships, with all the latest facilities for the rapid loading and discharging of cargo, including nine powerful steam winches, exhausting to a Contraflo winch condenser in the engine room, and ten derricks; a powerful, quick-warping steam windlass is fitted forward with steam steering gear amidships and hand gear aft. Electric light is fitted throughout, including large clusters at each cargo hatch. The vessel is fitted with additional bulkheads in the upper 'tween decks to minimize the risk of fire spreading from one end of the ship to the other. The captain, officers and engineers are berthed in large houses on the shelter deck amidships, and the sailors and firemen under the fore part of the shelter deck.

Triple-expansion engines will be supplied and fitted by Messrs. Richardsons Westgarth & Company, Ltd., Hartlepool, having cylinders 26 inches, 42 inches and 70 inches by 48 inches. Steam is supplied by three large single-ended boilers, working at 180 pounds pressure. The auxiliaries include a Contraflo main condenser, a Contraflo surface feed heater and Cascade filter.

A New Fuel Lighter

Where rapid loading and unloading of vessels is essential, as on the Great Lakes, rapid coaling of steam vessels is also necessary, and to accomplish this purpose many types of lighters especially adapted for rapid fueling have been brought out. One of the latest of these, and one which is claimed to be the most rapid vessel of this type, has been placed in use in Cleveland harbor for the Pittsburg Coal Co.

The lighter consists of a steel hull, 156 feet long over all, with a width of 40 feet over all. She is propelled by twin screws, her engines being designed to give her a speed of 12 miles an hour. The carrying capacity of the lighter is 1,000 tons, and it is claimed that she will load 400 tons of coal in the bunkers of a steamer in an hour. The lighter was built by the American Shipbuilding Co.

The arrangements for coaling consist of twenty pockets, located ten on each side of the hull, in which the coal is carried. Each pocket has a capacity of 50 tons, and is provided with two gates, so arranged that the flow of coal to the reclaiming conveyors is accurately controlled. The conveyors operate toward the center of the boat, where they discharge into an elevator, which lifts the coal to a swinging boom provided with a drag conveyor. A swinging and telescoping chute is fastened at the end of the boom, so arranged that it is possible to discharge coal into the bunkers of the largest steamers without trimming. With this arrangement the coaling can be done with a minimum crew, as only four men are required besides the captain.

The conveyor and coal-handling machinery are driven by independent motors controlled from the operator's house placed on top of the elevator.

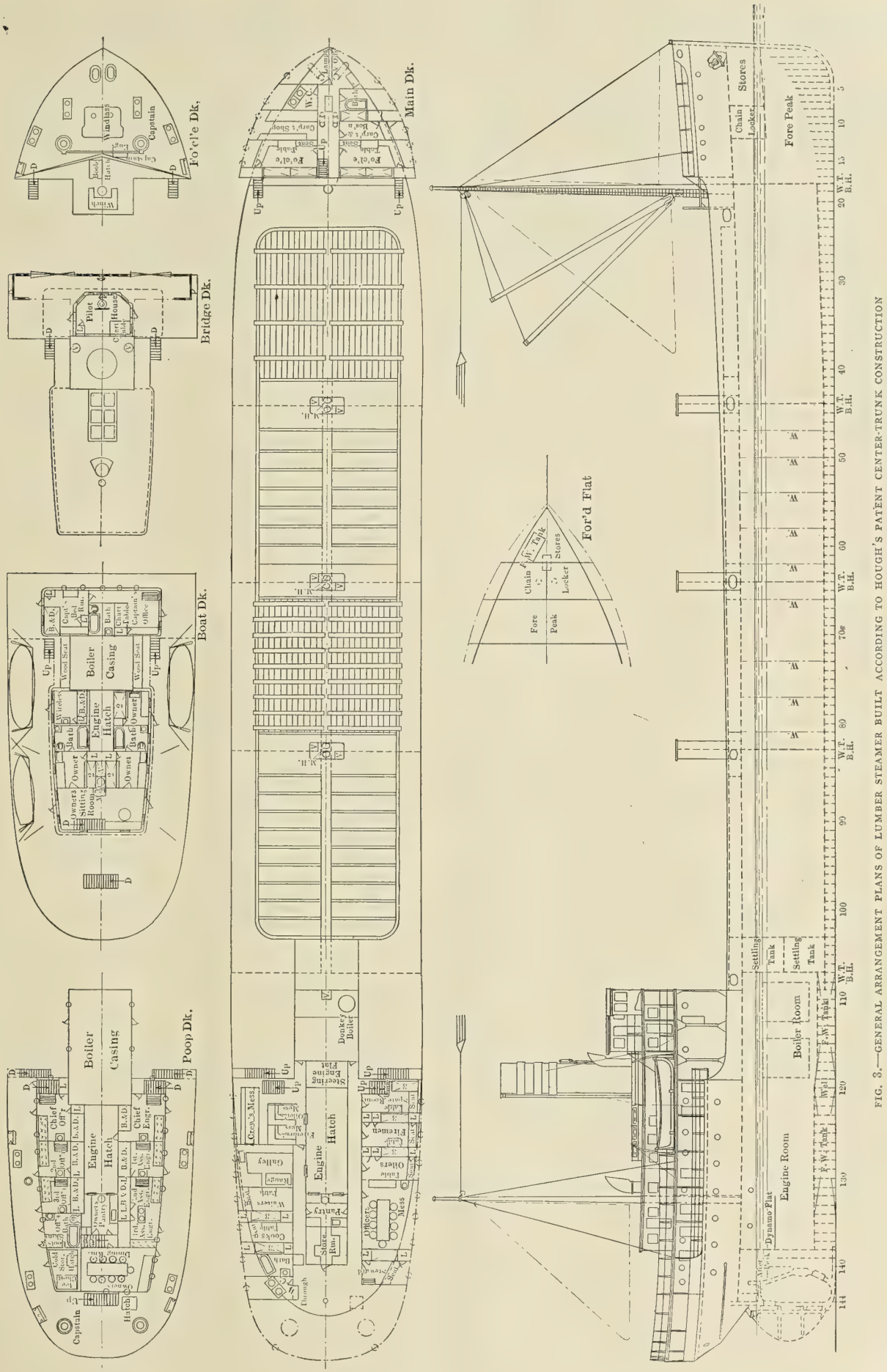


FIG. 3.—GENERAL ARRANGEMENT PLANS OF LUMBER STEAMER BUILT ACCORDING TO HOUGH'S PATENT CENTER-TRUNK CONSTRUCTION

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Overhauling Winches

Deck steam service gives as much trouble at times as all the rest of the ship's gear put together. One of the most annoying experiences out of all the troublous happenings at sea is to be dressed ready for an evening ashore, and just as your foot is on the gangway to have the chief call out: "Mr. ——, your No. 4 winch is stopped; you had better see what is the matter." With a face as long as the Western Ocean, you get below and change, find your tools, and, with a feeling of bitter hatred at heart towards winches in general and that brute in particular, you hunt round for the trouble.

Further annoyance is caused usually when cargo is being whipped, the winches running continuously at full bore. The donkeyman rushes up to tell you that he cannot keep steam up. The usual remedy is to light up a main boiler, which is against all the rules of your company.

One ship I joined when the cargo was being sucked out at top speed. I got so very sick of spending half the day and the best part of the night tinkering at winches that I approached the chief on the matter. Although he was very sore on the subject, I enlisted his aid. The result was that he talked the matter over with the superintendent and got what I asked for. Before sailing for a run to China I looked the winches over carefully and gave the chief a list of what I required for a complete overhaul.

I ordered a complete outfit of piston rings, and, finding that all pins were slack in the valve motion, got a new set of turned pins 1/16 inch larger in diameter than the originals. A couple of reamers for holes of running size to new pins and a set of radius blocks for the links were also indented for. Forged steel keys for the sliding pinions were also obtained. New valve-rod nuts and neck bushes to suit the piston and valve rods were also made ashore.

The pistons, rods, guides and connecting rods, also the valve gear of one side of the winch, were taken down successively to the engine room and thoroughly overhauled. Piston rings were filed to fit the bore of the cylinder in the proper location for the steady pins in the piston. The guide bars were filed straight and new oil channels made. Holes in the valve gear were reamed and new pins fitted. The crankshaft was taken down below, the journals touched up, the eccentric sheaves tightened, straps adjusted and made a good, solid job with no liners. Where the sheaves were out of round, as tested by the straps, they were filed as close as we could get them.

I found it necessary, so badly had brasses been adjusted—some of them had an assortment of six liners each side—to solder thick liners on to the brasses to make a solid job. New studs and bolts were made and fitted where necessary.

The crankshaft having had new keys fitted for sliding pinions and thoroughly overhauled, was replaced and adjusted in the bearings. The next process was to line up the engine both sides.

A piece of flat ⅛-inch steel was made having a slot to take two studs on the cover end of the cylinder and being provided with a string hole in the center. The crankpin was turned up to half-stroke, and a string with a weight on the end from the hole in the string guide, central both at cylinder cover and stuffing box, led through.

The bottom guide bar was then bolted up and lined to suit half the depth of the crossheads. The piston rod and crosshead were then slipped into place, and the top bar adjusted to suit the travel of the crosshead. The bottom bar should be tested with a straightedge for spring, and a single liner only should be used under each end of both bars. The piston is now put on after the new neck bush is put in place and the gland hung on. The cover joint is made, thus boxing up the cylinder.

The piston was then bumped either end of stroke and a line scribed on the top bar to show the extremity of travel. After the crank-pin brasses have been carefully adjusted to the pin, couple up the rod and test the clearance at each end of the cylinder by turning the crank and noting the distance the crosshead is at each end of the stroke from the marks made on the top bar. By halving the difference found, the thickness of the necessary liner at the foot of the connecting-rod is obtained. Do not give the cylinder unnecessary clearance by using a thick cover joint. Brown paper and boiled oil is a quite good joint. The foregoing was completed both sides of the winch.

The valve gear gave more trouble. The forged blocks put aboard for the quadrant links proved to be ¼ inch too large in every dimension, and, as we had twelve winches, this meant twenty-four blocks to be chipped and filed all over, or 144 faces in all. The metal proved tough, and I gave them up reluctantly as a bad job. The existing quadrant blocks were ⅛ inch slack to link after the latter had been filed parallel in the radius. To meet the case I made Guntz metal shoes of ⅛-inch metal, turning over the ends square to fit the blocks.

These shoes I tinned with a soldering iron on the inside all over. Next, taking a piece of ¾-inch steel plate, I made this a good, red heat and stood two blocks upon it, with soldering fluid, solder and iron and a large supply of patience, especially the latter. I succeeded in tinning the face of the block, placing a good dose of solder on the tinned face and laying the shoes for a moment or so face down on the hot plate. I slipped the shoes over the block and quickly placed the block in a vice and kept the shoe nipped on it until cold. A few rubs with a file and I had a beautiful fit in the radius link. No pins to secure the shoe were used, as the fork of the valve rod would prevent the shoe working out, even if it became loose.

As a matter of fact, when in Antwerp, four years later, I found the same steamer discharging there. Going aboard, I found my shoes were still in place and tight as a bottle.

The swinging links of the reversing gear were reamed out at the pins with the rest. The adjustment of travel of the radius link was done by drilling holes in the reversing lever quadrant and driving taper pins home at the extremity of travel, so that the blocks could not bottom in the radius links. In fact, I allowed ½ inch clearance at either end to increase the economy of working.

Valve faces were broken up with a file and trued as far as possible. The cylinder face of the valve being difficult to get at, we contented ourselves with breaking this up with a block file. The horns of the valves close to the nuts were dressed off flat, and the valve motion was adjusted to set the valve by single liners under the foot of the eccentric rod.

As Tuck's or round canvas packing, usually employed to

pack winches, is unsatisfactory, the packing (wire-woven asbestos) for the high-pressure main engine valve rod was split lengthwise into suitable sized square pieces and used to pack all the glands.

The twelve winches took all four of us working all our time off watch for five weeks, and some part of our watches as well. But during the remainder of the time I was in the steamer (two years) the winches were never touched, except to pack. During this period the winches were running 150 consecutive days continuously, frequently 12 and 14 hours at a stretch. We did a spell of coasting trade and never had a winch breakdown.

Many chiefs have a belief that winches were put on board to give healthy exercise to their juniors, and think that unless the juniors are overhauling winches piecemeal more or less on every run they are neglecting their duty. But it is my firm opinion that one complete overhaul once in eighteen months or two years is ample, if thoroughly well done. Also, there is a tendency to follow the practice of the main engines and use a number of liners for winch brasses. Experience has shown me the fallacy of this. Winch brasses should be metal to metal, no liners whatever being used except a single thick liner at each end of the guide bars and liners under the foot of the eccentric and connecting-rods. The clearance at the ends of the stroke on pistons are frequently neglected, both on main engines and winches.

Increased economy in fuel is quite marked by careful adjustment of auxiliary gear, and badly adjusted winches run away with more coal than they are ever given credit for.

As an instance, I was consulted in reference to a small steam plant ashore, which did not develop the required amount of power and seemed high in its consumption of coal per horsepower. Upon putting the plant under the proper test conditions, I found that the boiler feed pump was using 15 percent of the total amount of steam produced.

Deck service steam joints have a happy knack of giving out at inconvenient times. Frequently long ranges of pipes are fitted without provision for expansion. One range of copper pipe I sailed with had no such provision. In 50 feet the expansion endwise was 10 inches as measured. Under these conditions nothing but trouble with joints or deformation of the pipe could be expected. As a remedy, bowling hoops, large vertical round turns of pipe 3 feet in diameter, were fitted on each range of pipe, either against rails or deckhouse, and no further trouble was experienced, the elasticity of the hoop taking care of the expansion.

In conclusion, were I a superintendent of a line of, say, fifteen steamers, doing a regular trade, it would, I think, pay the company well if I secured a really competent man and paid him well to look after the deck gear. I would put him on board with a lathe, boring apparatus for cylinders, valve seating gear and quite a big kit. He would sail in that ship until he had everything quite O. K., drop off at a convenient port and transfer to the next steamer along, keeping all his tackle going until he had made a complete round of the vessels of the company. The junior engineers would give him help, and he would, subject to certain written orders, be under the orders of the chief.

Such a course would save many a heavy port bill for the owners; the work would be efficiently done, the chief being held responsible for the proper employment of the suggested man's time. As a rule, the type of man who does what is despairingly called dock-walloping does as little as he can, and that as badly as possible. By the employment of the course I suggest there would be no incentive to do the work other than well. As the tackle would be continuously employed, it would cost less than putting in expensive gear as a permanent addition to the ship's outfit. A. L. Haas.

London.

How to Deal with a Loose Crank Pin

The usual method of construction where cranks are not forged solid, but built up (and the latter method is almost essential for vessels of large size), is to turn the pin a shade too large for the hole bored in the web when the parts are cold. The webs are then brought up to a good red heat and, while they, and the pin holes in them, are thus expanded, the pin is placed in the holes. When this has been done cold water is poured over the whole work, causing the web to contract onto the pin and grip it firmly.

This method of contracting the webs onto the pin, while a very satisfactory one, if the job has been well done and if the pin has been proportioned exactly so as to have a good shrinking fit, sometimes leads to trouble at sea, inasmuch as the coefficient of expansion of mild steel is small and it is difficult to exactly gage the right diameter of the pin relatively to the holes. Should the pin work slack great trouble is given to the engineers, and if it is allowed to remain slack for any length of time it can easily lead to a total breakdown of the engine.

When a slack pin is found the engine must be stopped at once, if the vessel is not on a lee shore or in the midst of traffic, and in any case very great care must be taken, as the working of the pin in the web would soon make it a bad breakdown. The crank should be placed upon its top center and four or more holes should be marked off, in such a position that the holes, when drilled, will be half in the pin and half in the web. It will be found that 1-inch tapping holes will be about right. These holes should be carried into the metal about the thickness of the web, and should be tapped. Some screwed plugs should then be made a good tight fit in the holes, and it will be found that this will make a sufficiently strong and sound job to bring the ship home under full steam. T. T. F.

Auxiliary Electric Plant Driven by an Oil Motor

The recent appalling disaster to steamship *Titanic* must impress everyone with the great difficulties under which those in charge of a ship work when passengers have to be transferred to the boats, and it is obvious that this difficulty is enormously increased if this transfer has to be made in darkness. In the case of the steamship *Titanic* the special construction of the ship with boilers in small groups in separate compartments appears to have enabled the engines driving the dynamos to have continued at work long after the collision. In most ships such a collision would have almost immediately allowed water to rush into the boiler rooms and put out the fires, thus shutting down the engines and throwing the ship into darkness, which, undoubtedly would have increased the loss of life. The White Star Company evidently realized this possibility when designing the steamship *Titanic*, but a further development by the same company in the same direction will perhaps interest the readers of this journal.

The installation referred to was installed a little while ago on the new White Star liner *Megantic*, by Mirrlees, Bickerton & Day, Ltd., on behalf of the White Star Company and Messrs. Harland & Wolff, having for its object the continuance of the Marconi apparatus, and of a considerable portion of the lights, even after the whole of the steam machinery below has been stopped by an accident such as that mentioned above. In this scheme a 45-brake-horsepower Mirrlees-Diesel oil engine, directly connected to a dynamo, is installed on an upper deck, and from the dynamo a separate circuit is taken round the ship and connected with lights fixed in the main passages, companionways, saloons, etc. This circuit is also arranged to provide lights in the neighborhood of the boats, in addition to being connected with the Marconi apparatus.

From the above description it will be seen that in case of a serious disaster such as that on the steamship *Titanic*, a supply of electricity would be continued on board the ship and give light for the free movement of people about the ship, also for the launching of the boats, as well as giving current for the wireless telegraphy right up to the last moment when the upperdeck sinks below the sea.

The installation on the *Megantic* is set to work daily as darkness approaches and continues until daylight, quite irrespective of the fact that the steam-driven electrical dynamos are working. This is done so as to avoid any rush or hurry to start up the plant in case of anything happening in the night. Of course, an independent plant of this kind could be driven by other forms of engines than the Diesel, but with steam or gas engines the space occupied would be greater and the handling of coal on an upper deck would cause considerable nuisance. Gasoline (petrol) or kerosene (paraffin) engines might be suitable for the work, but the oils they use would be quite unsafe on board a large ship, and in fact are prohibited by Board of Trade regulations. The oil used on the engine just mentioned is cheap residual petroleum; *i. e.*, the heavy residue left from crude petroleum after all the light oils have been distilled off.

It is believed that the arrangement described is a life-saving appliance of the greatest value, as with ample light boats can be much more quickly and safely launched than in darkness or semi-darkness. Also, the extended time during which the wireless telegraphy apparatus can be worked gives a greater chance of help being obtained. The fact that the White Star Line has been the first to try this scheme proves their desire to do everything possible to secure the safety of their passengers.

CHAS. DAY, Managing Director,
MIRRLEES, BICKERTON & DAY, LTD.

Hazel Grove, near Stockport.

Two Breakdowns

An air pump plays such an important part in the economy of the marine steam engine that a breakdown not only causes stoppage, but if the damage is beyond the limited resources of the engine room such a breakdown leaves a steamer in an awkward plight. All the pumps in an ordinary 10-knot freighter are driven by levers from one engine (high-pressure, intermediate-pressure or low-pressure); practically no important part is carried in duplicate, as the breakdowns usually are confined to replacement of valves.

A steamer left Marseilles for the Black Sea, returning 16 hours later for repairs, with steam coming through the engine-room skylight in volumes as she proceeded to a berth. The cause was curiously simple. The air pump was overhauled in port, the valves (of fiber) in the bucket were replaced by new. The distance between seat and guard of the valves was ½ inch, the valves 5/16 inch in thickness. These valves were of such poor material that after a short spell of duty they swelled up tight to the guards, when the descent of the bucket on an unyielding mass of water played the mischief all round. The air pump rod was bent, a pump crosshead bent, both caps of the bearings were torn off at the fulcrum of the levers, breaking away part of the framing on the columns. The levers themselves were also badly twisted. Thus at one stroke the whole of the pumps were rendered useless.

After a short consultation, the chief decided to put back to Marseilles for repairs. To do this the low-pressure engine, by which the pumps were driven, had the slide chest cover removed, and after clearing up the wreck a bit the steamer arrived back in port exhausting steam into the engine room. The donkey pump was used to feed the boilers, sea-water, of course, being used. Repairs occupied four days, the defective fiber valves which caused the trouble being replaced by metal disks of the Kinghorn type.

The second case was even worse, as the steamer on which it occurred had about 1,000 miles to run to her destination, the only explanation possible being that the feed pumps were defective, failing to deliver to the boilers for an appreciable time before the smash came. A quantity of water, therefore, accumulated in the condenser, and the motion of the ship thus projected more water into the air pump than could be dealt with by the overflow. The barrel of the pump burst, the cover was wrenched up, the rod bent double and the bucket torn off, twisted and broken in several pieces. Repair was out of the question. Fortunately, the damage was confined to the one pump, the remaining pumps being good and serviceable. A long run was completed with no air pump and without a vacuum on the condenser.

To prevent the possibility of internal pressure, a hand-hole was removed from the top of condenser; connection was made to the bottom by means of two pieces of flanged steam pipe taken from the deck. The bottom of the feed pumps having covers, made this easy at one end, but the bottom of condenser was drilled and studded to form joints there.

A slower run was made by the steamer, but the results were creditable; and—although I do not remember all of the details—the condensed water was fed back to the boilers, and the diminution of speed not so great as might be expected.

It was fortunate that the steamer was of a modern type, in which the pumps were lower than the condenser, as feed pumps of the ram type on the main engines are unsuitable for a suction lift, the pump chamber filling by gravity. This is arranged for when the pumps are fed in the ordinary way, the hot-well being level with the suction valves of the feed pumps.

Failing the method used, it would be possible in most ships to circulate the condenser with the bilge donkey pump, feeding the boilers with the feed donkey pump, using connections provided for the purpose. But these pumps are provided for duties of an intermittent character, cases having come under my notice where the feed donkey failed to deliver into the boilers while under full steam. In any case, a good deal of trouble would have been experienced using the donkey pumps in this fashion. Modern boats of a better class now carry their pumps as auxiliaries, being separate from the main, as quite 60 percent of minor breakdowns on the older type engines were due to pump troubles.

In a steamer having the pumps lower than the condenser the foot valve usually fitted to the air pump can be dispensed with, even if the pump is not of the Edwards type. In the first case the breakdown could not have occurred if the foot valve had been absent, the mass of imprisoned water between bucket and foot valve being responsible for the damage done. The valves were of a bad type. Fiber has always a tendency to peel, and I consider the makers of the defective valves morally liable for the damage done.

In the second instance the overflow from the hot-well back to the condenser must have been small or choked; the cause quoted seems to be the only possible to meet the particulars brought under my notice at the time. As cessation of the clack of the check valves should have been noticed as soon as it ceased, some amount of blame would seem to rest on the charge of neglect.

OBSERVER.

The *Hardware Trade Journal*, the *Cabinet Maker and Complete House Furnisher*, the *Goldsmith's Review*, the *Export World*, *El Comerciante Argentino* and other publications issued at 31 Christopher street, Finsbury Square, London, E. C., by several companies, have all been amalgamated with Benn Bros., Ltd. Mr. E. J. P. Benn, managaing director of the new company, is director and publisher of INTERNATIONAL MARINE ENGINEERING at the same address.

Review of Important Marine Articles in the Engineering Press

On the Measurement and Automatic Recording of Dead Reckoning.—By F. R. S. Bircham. The paper proper considers the work already accomplished in this line by others, describing briefly their inventions and the service they render. The author then presents a summary of the requirements for a machine such as is needed for the accurate automatic recording of a ship's course, making allowance for turns, error in distance while ship is altering speed and error in course when following. The requirements which he considers necessary for the device are: 1. The placing of small craft on the same level with larger ships in regard to dead-reckoning position, and enable that position to be read off instantly at any moment. 2. Ability to be operated by a person not skilled in navigation. 3. Ability to work out a position more accurately than at present possible when speed and course have been altered frequently. 4. The recording of alterations of course on strip of paper and number of miles steamed and time. 5. Indicators to be resettable so that recorder may be corrected from time to time. In a lengthy appendix following the author then describes in detail a device invented by Lieutenant F. G. S. Peile, R. N., which fulfills the above-named qualifications. The mechanism being somewhat difficult to describe concisely that will not be attempted here. All of its operations are automatic, the adjustments and allowances being set by the navigating officer and requiring but a moment's attention, thus giving an accurate record even in times when the officers have little attention to give to the matter of dead reckoning. Illustrated with drawings.—Read before the Institution of Naval Architects.

The Shipbuilding Industry of Germany.—By Count Ernst von Reventlow. A general review of the growth of German shipbuilding, with reference to the legislation used for the assistance of private industry. Perhaps it is not so well known in the United States as abroad that German shipbuilding is of recent origin as applied to vessels of considerable size. For some time the leading German shipping companies bought their ships in England. There, orders of any size could be handled in the shortest time, and only the requirements of the German mail subsidies brought these orders to the home yards. It was through the foresight of Prince Bismarck, who introduced the bill into the Reichstag, that contracts were made with steamships built in German yards, and so far as possible of German material, for carrying the mails. This act, together with the naval shipbuilding brought to the yards on account of the upbuilding of the Imperial navy in the years following, has given the yards enough work to enable them to be brought to a high state of development. Especially after the *Dreadnought* type began to influence naval shipbuilding the leading yards enlarged their plants to accommodate the new order of work, and the policy of the German navy to build equal to the best has recently brought out several ships that are considered highly by naval constructors of all the Powers. The latter part of the paper is devoted to descriptions of the private shipbuilding yards in Germany, among which are the Vulcan Company of Stettin, the shipyard of F. Schichau of Elbing and Dantzig, Blohm & Voss, the Howaldt Works, the Weser Company, the Krupp Germania Yard at Kiel, the Bremer Vulcan and others. 9,500 words, illustrated.—*Cassier's Magazine,* April.

The Battleships of the New Kaiser Class.—A comparison of points of design, principally of armament, of the latest class of German battleships, as instanced in the *Prinzregent Luitpold,* recently launched, with the latest types in other navies. The principal dimensions and specifications of this class of ships are: Length, 564 feet 3 inches; breadth, 95.15 feet; draft, 27.2 feet; displacement, 24,500 tons. A speed of 22 knots is expected, and although the motive power given is 25,000 horsepower, the actual will probably be much more than this. As shown in a table accompanying, the size of this class exceeds that of the *Conte di Cavour, Jean Bart, Settsu, Hercules, Viribus Unitis* and *Petrapawlovsk,* but is exceeded by the *Arkansas* and the *Moreno.* The speed expected exceeds all those named except the *Petrapawlovsk* and *Moreno.* The main battery of the *Kaiser* class consists of ten 12-inch guns mounted in five turrets, so that six guns will fire ahead, eight astern, and all ten broadside. Indications are that the 14-inch gun will soon become the standard big caliber gun in the German navy. The armor belt is carried out to the ends of the ship. Time of building for the ships of the class averages about 37 months from laying the keel. 1,400 words.—*The Engineer,* March 29.

The Twin-Screw Motor Ship Selandia.—Paper Third. This installment of the series tells of the engine-room experience of a traveler on the *Selandia* and his opinion of how the Diesel motors behaved in actual practice. It was found that the engineers soon came to feel familiar with the new type and the voyage was uneventful throughout. The motors were a trifle more noisy than a well adjusted steam engine, but this may be improved with further experience. The vibration was noticeable in the immediate vicinity of the machinery space, but at least part of this was due to fast-running auxiliaries. The reversing was accomplished easily and quickly. To the average marine steam engineer the number of rods about the motors might seem excessive, but for the work to be done by them the number is a minimum. The engine-room staff was finished with its work a few minutes after tying up at the end of the voyage, there being no ashes to dump, fire to draw, or cleaning up to be done. The fuel consumption was given as 11½ tons of Roumanian residual oil per 24 hours for the full 2,500 brake-horsepower. This was slightly better than the guarantee. Illustrated with plate drawing of plan and elevation of engine. 3,500 words.—*The Engineer,* March 22.

A New Marine Diesel Engine.—An illustrated description of the new marine Diesel engine being built by Messrs. Franco Tosi, of Legnano. It is of 500 horsepower, two-cycle type with four cylinders and attached double-acting scavenging pump, run from rocker arm, and separate oil fuel pumps for each cylinder. Special features are the separate piston rod and connecting rod, arrangement for examination of piston, water cooling and arrangement to start part of the cylinders on oil whereby engine may be run smoothly at dead-slow speed. A detailed description is given of the reversing mechanism. The large experience of this firm in other types of Diesel engines augurs well for success in the mechanical end of this design at least, and the general excellence of the design predicts for it a successful commercial career. 4,900 words.—*The Engineer,* April 19.

Parsons' Steam Turbines for an 18-knot Ocean Liner.—A complete detailed description of the machinery of this ship, whose name is omitted but may be readily guessed. The installation is compound, consisting of one high-pressure turbine, having four expansions of sixteen rows of blades each and two low-pressure turbines in parallel, each having eight expansions of eight rows of blades. On the same drum with

the low-pressure turbines are the reverse turbines, each having four groups of nine rows of blades. The blading of all the turbines is so arranged that the thrust may be taken up as nearly as practicable by the steam pressure. Thrust blocks are provided for the difference in pressure of thrust, due to variation of speed from the designed speed. Numerous detail and assembly drawings illustrate the installation very clearly. On trial the plant has developed about 20,000 shaft-horsepower and drives the ship 18½ knots. The designed speed of the shafts was 290 revolutions per minute.—*Engineering,* March 22.

Marine Motor.—The description of a very satisfactory design of motor built by Messrs. Simpson, Strickland & Co., of Dartmouth as an auxiliary for the barge yacht, *Thoma II.* Besides being a description of this installation, the article is a commentary on the principles of gas-engine design in general and emphasizes the important features to be considered, especially that of accessibility, of all parts that need any attention whatever, the author claiming that this is desirable even more than any equivalent saving in weight, space, or cost. After showing how every part of this engine is thoroughly accessible, the author takes up in considerable detail the description of the lubricating system, arrangement for keeping moisture from the carburettor, and gearing of engine to the propeller shaft. The arrangement shows the motor placed up on deck and connected to the shaft by means of gears and a chain. The cylinders are not only placed slightly off the center of the crankshaft, but the entire engine is placed considerably off the center of the boat. The engine has four cylinders, 4¾ inches by 5½ inches, which give 32 horsepower at 800 revolutions per minute. Illustrated by drawings and photographs. 4,900 words.—*The Engineer,* May 3.

A Commercial Type Marine Motor.—This article deals with the mechanism of a four-cylinder oil engine designed for the heavy service of fishing smacks, barges, and such craft. The motor's cylinders are 8¾ inches diameter and 10¾-inch stroke, and at 350 revolutions per minute develops 38 brake horsepower on a consumption of 0.63 pint of Rocklight oil per horsepower hour. The general design is very good and shows much care and forethought in providing in convenient places on the engine location of the numerous auxiliary parts. In operation it is said to be quite satisfactory. Blow lamps are used to heat the vaporizer when starting. Two ignitions, Bosch high tension magneto and coil and accumulator, are fitted. Reversing mechanism is quite heavy and suitable for the rough handling to which it is liable. Accessibility has been well emphasized in the design. Well illustrated with photographs and drawings. 5,200 words.—*The Engineer,* May 10.

Engine and Boilers for a Dutch Colonial Government Steamer.—A complete equipment of propelling machinery has recently been supplied by Messrs. McKie and Baxter, of Glasgow, for the Dutch Colonial Government. The plant consists of two large Yarrow boilers so designed that coal or oil may be fired with very little change of fitting, and a four-cylinder triple-expansion engine driving a single screw. The engine has cylinders 16, 26, 30, 30 inches diameter and 24-inch stroke, balanced on the Yarrow-Schlick-Tweedy system, and expected to develop 1,500 indicated horsepower at 200 revolutions per minute. The condenser, which is constructed on the Contra-flo system, has a cast brass body. The main steam pipe is of solid drawn steel. The fuel-oil apparatus is on the Wallsend Slipway Company's system and works in conjunction with the forced draft system and heated air supply. Illustrated by photographs and several sheets of drawings. 500 words.—*Engineering,* May 10.

Electric Power in Railway and Marine Terminals.—By R. H. Rogers. This article tells in a general way of the greatly developing need of adequate terminals in handling railway and steamship traffic, and shows the direction in which this need is being met in New York by the Bush Terminals and in Seattle by the newly planned Harbor Island Terminal. The opening of the Panama Canal will see such a great and sudden increase in traffic that few ports will be able to take care of the increased business which will come to them. The obvious solution, it is claimed, is the use of electricity along the lines already begun at these two examples of terminal stations. Illustrated. 3,100 words.—*The General Electric Review.*

New Electric Welding Process.—Messrs. Siemund & Wenzel, electric welders, of Liverpool, have introduced a new method of electric welding which has been very successfully used. The method is as follows: The current is obtained from a generator running from 30 to 60 volts, direct current. This generator has an adjustable rheostat in series with the field, which, together with the field, is in shunt to the armature. The positive pole of the dynamo is connected to a quieting resistance coil, and from this coil to a welding clamp which holds the welding wire. The welding clamp consists of the main body and a spring metal blade, both of soft iron. The clamp is wound with a number of turns of insulated copper wire, which, being connected to both ends of the clamp, constitutes a branch circuit through which passes a portion of the welding circuit corresponding to the drop in tension between the points of the clamp, and magnetizes the clamp and also the welding wire, which is held by it to such a degree that as the molten metal at the end of the welding wire detaches itself, it will follow the lines of force and deposit itself at the point to be welded. Extensive repairs on such work as boilers, furnaces, plating, stern frames, have been successfully made. 1,400 words.—*The Steamship,* May.

Some Aspects of Diesel Engine Design.—By D. M. Shannon. Paper read before the Institute of Engineers and Shipbiulders in Scotland, April 23. The paper is full of figures and facts of practical importance for the Diesel engine designer. Commencing with a general consideration of the subject of efficiency of the Diesel engine as compared with the reciprocating steam engines and turbines, the author states that the oil reciprocating engine is only a step on the way towards the oil or gas turbine, whose difficulties none but the experimenters fully realize. The question of limits of size of the Diesel engine of the present form, he thinks, presents no insurmountable difficulty, and a design is suggested that would make possible as large a marine plant as any yet built or building with steam as the motive power. From this hopeful beginning, Mr. Shannon goes into the question of crank-shaft sizes, best number of cylinders and arrangements of cranks for twisting and bending moments, his statements in figures fortified by formidable tables and diagrams of loads and moments. Other points considered are main bearings, connecting rod caps and bolts, valve gear diagrams, and air compressors, this last in great detail. As a whole, the paper is one well worth study by all interested in oil-engine development. 5,900 words.—*Engineering,* May 3.

Radiotelegraphy with Special Regard to Ship Installation.—By Director Bredow, of Berlin. Abstracts of a paper before the thirteenth meeting of the Schiffbautechnische Gesellschaft. An account is given of the rapid commercial development of German radiotelegraphy to a leading position, and the scientific investigation which has resulted in present-day knowledge of what may be done and how best to do it, in this line of experiment. Taken up at some length are the subjects of range, wave length, influence of earth and atmosphere, power required, instruments, and the geographical distribution of stations. Illustrated. 3,900 words.—*Engineering,* May 3.

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The approaching completion of the Panama Canal naturally attracts the attention of the commercial world to the preparations that will be made for the increase of water-borne traffic which will result at the various seaports of the Atlantic, Gulf and Pacific coasts of the United States. The amount of shipping that will be brought to these ports will depend, among other things, upon the facilities which will be provided at the steamship terminals for the rapid and cheap transhipment of freight from the steamships to the railroads and to local destinations. The single operation of handling miscellaneous freight at the terminals forms such an important item in the cost of transportation that it should be given first consideration in any steps towards the improvement of terminal facilities. It is generally recognized that the terminal facilities at most American ports are badly in need of modernizing. The slow and costly method of doing this work by manual labor is still adhered to in the majority of cases in spite of the fact that in recent years nearly every important foreign port has spent large sums of money for the installation of extensive systems of mechanical appliances for handling freight. Since the ports on the Great Lakes have developed such highly efficient systems for handling bulk cargo it is not to be supposed that the seaports will longer delay action in improving the handling of general cargo at their steamship terminals. The seaports do not stand alone in this need, however, for the opening of the Panama Canal is expected to have an important influence on the development of marine transportation on the Mississippi River and its tributaries. Here the need of adequite river terminals and suitable connection with railroad traffic is even more imperative in order to reap the benefits from the work which has already been done in improving these inland waterways. Every port, of course, whether on the coast or on an inland waterway, presents its own problems according to its natural resoruces, but they all have this in common—the handling of miscellaneous freight must be accomplished in some more rapid and economical way than the present practice of depending almost entirely upon manual labor.

It is a common complaint among marine engineers that accurate data regarding the performance of marine machinery, except in the case of naval vessels, are difficult, if not impossible, to obtain. In only rare instances are complete tests of the main engines and boilers made in regular service. When a trial trip is undertaken it usually consists of nothing more than the necessary run from the builders' yard to the owners' pier and the only data available are the perfunctory statements that "the engines worked very satisfactorily" and that "the ship attained its contract speed, or a little better." The main engines may be indicated or the shaft horsepower measured if turbines are installed, and a fairly accurate estimate of the power developed ascertained, but for any accurate figures as to the amount of fuel consumed, the quantity of water evaporated per pound of fuel or per square foot of heating surface or the amount of steam used by the main engines and auxiliaries under various conditions, the engineer must depend more or less upon guesswork based upon the average performance of the vessel for a season's run as indicated by the company's fuel bills and other approximations. Where oil fuel is used the engineer has an opportunity to determine with a very considerable degree of accuracy the actual amount of fuel used, providing the measurements of the contents of the oil bunkers are carefully made. A most useful and accurate method of doing this is explained in an article which we are publishing in this and the following issue. The author, whose experience along these lines enables him to discuss the subject with authority, explains the probable causes of inaccuracies in the determination of such figures and outlines the method of procedure for accurately obtaining them. With the increasing use of oil for fuel in the merchant marine service many of our readers will no doubt have an opportunity to apply this method and secure some information as to fuel economy that can be looked upon as reliable.

Improved Engineering Specialties for the Marine Field

The Oxy-Blaugas System

What is claimed to be a great advance in the progress of the metal welding and cutting industry has been brought about recently through the introduction of the Oxy-Blaugas system by the Atlantic Blaugas Company, of New York. While this system is operated in practically the same manner as the various oxy-acetylene systems, it has numerous advantages from a commercial point of view. Blaugas, which is used in combination with oxygen in the usual manner, is a compressed liquefied distillation gas produced from mineral oils. In the process of its manufacture the gas is reduced to 1/400 of its volume and all poisons and impurities are removed. One cubic foot of expanded Blaugas contains 1,800

British thermal units. Blaugas is especially well adapted for welding, cutting and brazing purposes on account of its exceptionally high heat value, its very narrow explosive range and its unparalleled transportability. The explosive range of Blaugas is only 4 percent, this being the narrowest range of any known commercial gas.

Blaugas is sold by the pound in steel cylinders, 43 inches high and 8 inches in diameter. Cylinders contain an average of 20 pounds of liquid Blaugas, which is sold at a standard price of 10 cents (5 pence) per pound. Each liquid pound expands into 12½ cubic feet of free gas, and from the above it may be figured that each cylinder contains approximately 250 cubic feet of gas at a price of only 4/5 cent (.4 pence) per cubic foot.

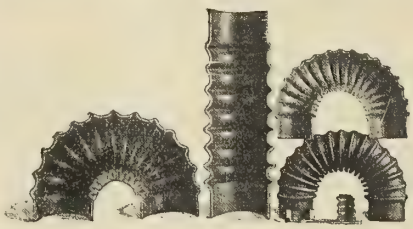
Taking into consideration the extremely low price of Blaugas, and the fact that amazingly large quantities are contained in small, easily-handled bottles, it may readily be seen that this system of metal welding and cutting is exceptionally economical.

A very important advantage of Oxy-Blaugas welding over the other autogenous welding systems is that the flame of the Oxy-Blaugas torch is much broader than that of the torches of the other systems, thereby insuring a greater and more uniformly heated area of the metal to be welded and preventing the high tension in the welded material. It is a well-established fact that, through the great differences of temperature produced in the material to be welded, a tension is created within the immediate area covered by the flame, and if the metal is subjected to tensile strength test it will frequently break directly beyond the weld, which disadvantage is greatly lessened with the Oxy-Blaugas system.

Besides being a most desirable medium for all welding, brazing and metal-cutting work, Blaugas is also used very largely for lighting, cooking and heating in homes, yachts, vessels, etc.

Elastic Corrugated Tubes

O. N. Beck, 11 Queen Victoria street, London, E. C., has on the market a special line of corrugated tubes, made of either seamless steel tubes or, in larger sizes, wrought iron tubes welded with overlapping seams and rerolled for use in pipe lines where bends of small radii or expansion and vibration joints are needed. The tubes are also useful for increasing the heating surface of boiler and superheater tubes, as well as relieving the strain on boiler heads and increasing

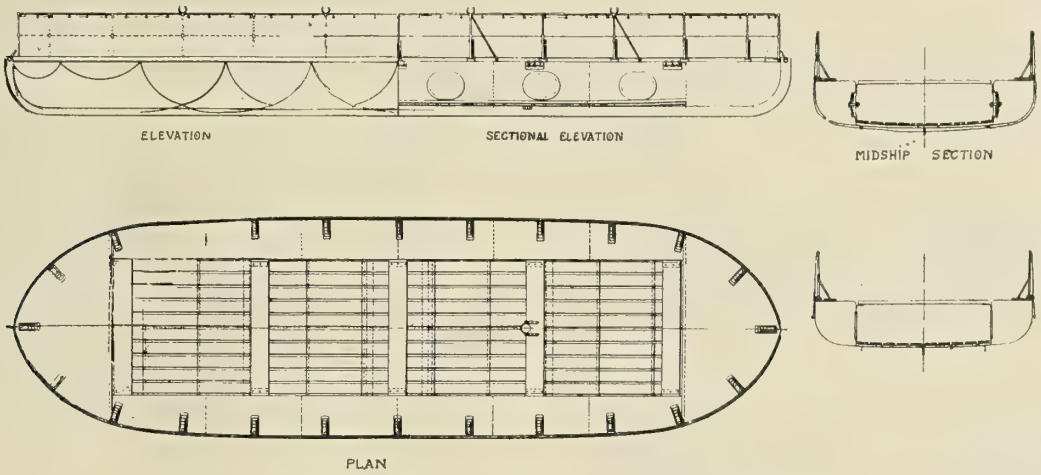


the whirling motion of steam. The peculiar method of manufacture by special machines of registered design ensures an absolutely uniform thickness of metal in all parts of the tubes. The tubes are manufactured of an inside diameter of from 35 to 450 millimeters. The inside diameters and thicknesses correspond to the standard sizes of boiler tubes. The process of manufacture is such that, after pressing out the corrugations which always arch outwards, the pipe retains its exact original internal diameter throughout, the corrugations being parallel and not spiral, as in the ordinary well-known flexible tubing, affording therefore a certain amount of axial elasticity.

It is interesting to make a comparison between the ordinary loop joint and an expansion joint made of corrugated tubing. The maximum compensating capacity of the well-known type of expansion bend of a bore of, say, 10 inches, length of 10 feet and a projection of 10 feet, is 2 inches, while a bend made of corrugated tubing will, with a length of 4 feet 7 inches and a projection of 5 feet 3 inches, take up an expansion of 5½ inches. Thus a pipe range in which an expansion of 5½ inches has to be accommodated would require three ordinary loop joints of a total length of 86 feet, or only one piece of corrugated tubing of about 15 feet. Apart from the considerable amount of space taken up by these huge bends, which, of course, is not always available, the corrugated joint not only ensures a smaller degree of cooling, owing to the very considerably shorter length, but also entirely obviates all strain on the flanges and connections.

Seamless Steel Semi-Folding Boat

The boat illustrated is designed by the Seamless Steel Boat Company, Ltd., Wakefield, to retain the special features for which the standard seamless steel lifeboat is noted, *i. e.*, strength, durability and seaworthiness, absence of leaking, and yet at the same time occupy much less room on the ship's deck than the ordinary boat. The lower part of the hull up to beyond the load waterline is made in the usual manner of seamless steel boats; each side consisting of one sheet of galvanized steel riveted to a T-bulb section mild steel keel bar; the upper portion of waterproof canvas forms a shield from the wind and spray, and is not an essential portion of the floating capabilities of the boat; the steel hull being completely buoyant and seaworthy in itself. The canvas is supported by galvanized iron stanchions, which hinge down upon the seats, and can be easily raised and are automatically held in position when upright.

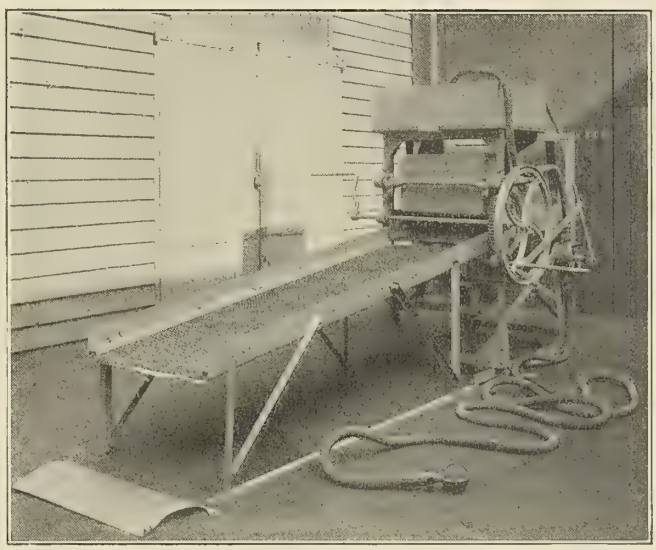


A great advantage claimed for the seamless steel boats is that the method of construction permits the air-tight cases (or buoyancy chambers) to be built into the hull itself, serving the double purpose of strengthening the hull and of floating the boat and the passengers even when the boat is full of water. The method of constructing these tanks is, briefly, as follows: About 3½ feet from each end of the boat a watertight steel bulkhead is fitted, on top of which, reaching right to the end, is fitted a watertight steel deck, thus forming the ends of the boat into air-tight chambers of large capacity. Along each side of the boat are fitted steel plates, pressed to such a shape that when riveted to the hull they form continuous air-tight compartments from bulkhead to bulkhead. For further safety, however, these are divided into six separate chambers by means of watertight division plates, the total capacity of the buoyancy chambers being so much that the boat (loaded) would float even if two of them were pierced. Watertight doors are fitted to each compartment to give access for inspection, cleaning or painting, the door being either of the single-bolt fastening type (as shown in upper section), or of the ordinary lid type with set bolts (as shown in lower section). Lifelines are becketed right along the sides, extending to the keel, so that if the boat were floating overturned they would afford a means of clinging to and obtaining a foothold on the bottom of the boat. The alternative section of the boat on the drawing shows bilge keels fitted with hand grips instead of the lifelines along the bottom, as this method may be preferred in some cases.

Seating accommodation is provided for forty passengers, and the boat is capable of carrying at least seventy. Rowlocks are fitted for rowing, with fittings for mast and sail and hooks or slings for lifting on davits.

Improved Alluvial Hand and Power Washing Machines

The alluvial washing machines manufactured by Arthur R. Brown at 54 New Broad street, London, E. C., comprise the following special features: The height to which the material has to be shoveled is very much less than in other machines, and the special jigging action of the boxes is claimed to give a more perfect separation of the particles of gold or other metals that are required to be separated from the gravel. The height is reduced owing to the two boxes being jigged in opposite directions, which allows the material to drop direct from the lower end of the top box to the upper end of the lower box, thus dispensing with the fixed inclined shoot used in other machines to deliver from the top to the bottom box. Another advantage is that the material not only passes over two jigging boxes but passes over as well a stationary sluice box, which has the advantage of not only



giving an extra large area for saving the gold but also enables the tailings to be carried some distance away from the machine.

The machine can be worked by one man working the handle on the fly-wheel, or by two men, and the pump can either be worked separately or from the fly-wheel. In places where it is possible to get horses or mules, it is an advantage to have, in addition to the machine, a horse-gear, arranged to work either one or two machines, thus leaving the man free to shovel the gravel.

The material is shoveled into a hopper at the top of the machine, whence it falls on to a grizzly, where the large

stones are separated out and the fines fall through on the expanded metal and matting on the bottom of the top box. After the fines have been jigged down to the lower end of the top box, they fall on to the upper end of the lower box, and are then jigged in the opposite direction down a sluice box.

Two sets of matting are supplied to each box and sluice box, and one set of expanded metal, also 30 feet of suction and 10 feet of delivery (armored) hose. The shipping weight of each machine is approximately 16 cwts. without the horse-gear. The shipping weight of the horse-gear is approximately 10 cwts.

Dermatine Cup and Ram Rings

Dermatine is a metal which it is claimed will stand more wear and rougher usage than leather, rubber or gutta percha, and it is, therefore, used in the manufacture of many of the articles which formerly were made of these materials. The manufacturers are the Dermatine Company, Ltd., 93 Neate

FIG. 1

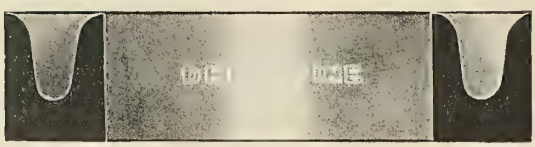


FIG. 2

street, London, S. E., and two of the products of this company in which Dermatine is used in greater quantities than any other are belting and hose. A special grade of suction hose, which is manufactured with imbedded spiral wire, is particularly useful for marine work.

Dermatine valves, both flexible and hard, fitted with patent anchor bushes, which add much to the length of the life of valves for air pumps and force pumps, have been described in previous issues of this journal. Dermatine valves are particularly adapted to resisting steam and oil, and are therefore useful for all kinds of pump work. Dermatine has also been applied to the construction of pump cups, as shown in Fig. 1, and its use has been found to increase the life of rings for hydraulic apparatus far beyond the life of leather rings. A special design of Dermatine rings is shown in Fig. 2, which is called the Dermatine hydraulic "U," or ram ring.

Oxy-Acetylene Apparatus for Ship Work

With oxy-acetylene apparatus used for cutting on steel ships, barges and dredges under course of erection, it is claimed that the torch will cut manholes, strainer holes, etc., through the plate at approximately one-eighth the cost and time in which it would be effected by air chippers or other tools. The work can be done anywhere the operator can climb with the torch in his hand; the cut is narrow and smooth and requires practically no subsequent dressing up. Spots of manganese, etc., in the plate, which would dull and break cutting tools, offer little or no resistance to the flame and high-pressure jet of oxygen. Also, in the welding together of angles and building up sections and forms the welding feature of the torch shows a saving also very pronounced. A great advantage of the torch on the work is that it is handled by one man instead of having several men haul large pieces out of a big furnace and striking while the iron it hot, perhaps requiring two or more heats to finish a weld and resting between heats. By the oxy-acetylene method the sections are simply lined up in position, and one operator with the torch and its intense concentrated flame welds up the joint quickly and efficiently, and with no loss of time or handling.

A type of portable plant (Fig. 1), designed especially for welding and cutting in shipyard and similar work, is manu-

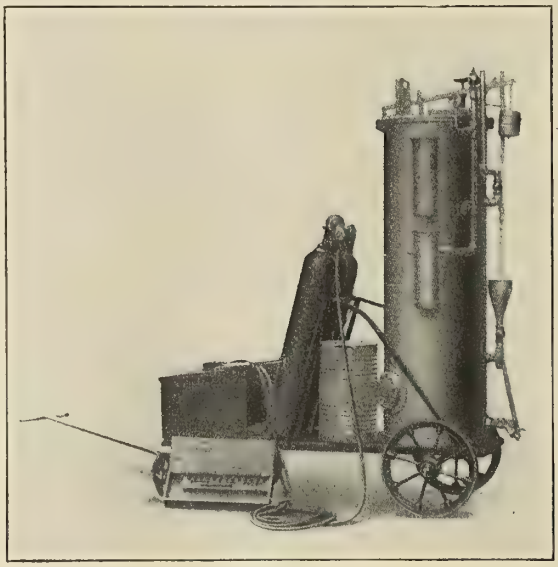


FIG. 1

factured as a part of the regular line of the Alexander Milburn Company, 505-507 West Lombard street, Baltimore, Md. The generator furnished is 50 pounds carbide capacity, automatic in operation, and assures an ample supply of acetylene at a low cost per cubic foot. The oxygen is supplied

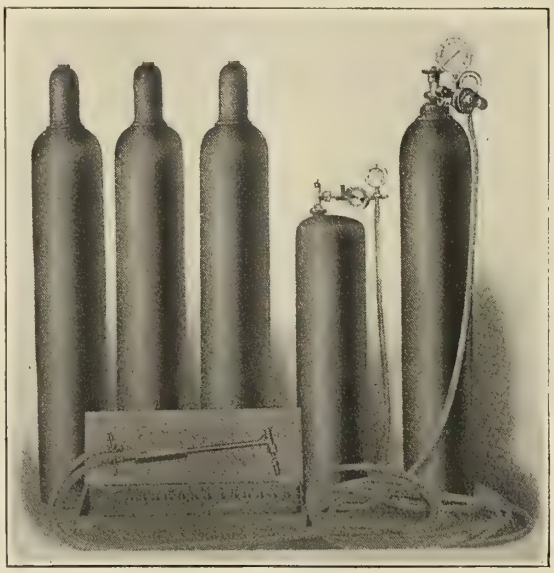


FIG. 2

in any desired quantity in portable cylinders, which can be carried always on hand.

Another equipment, which has been developed principally for wreck trains on railroads, but which should also be in the tool department of every important ship on the sea for emergency repair work, is the Milburn tank storage welding and cutting plant (Fig. 2). The essential parts of this plant consist of a tank of acetylene and a tank of oxygen, with valves, torch, hose, etc., packing into a space 2 feet square by 4 long, while the complete outfit, including a reserve tank of

acetylene and three of oxygen, giving ample supply for a large amount of repairing, takes up very slight space. All tanks as emptied in use are exchangeable for full ones at ports. By the storage tank system the acetylene costs somewhat more per cubic foot than by the generator system, as advocated for ship yards.

Technical Publications

The Lifeboat and Its Story. By Noel T. Methley. Size, 8¾ by 5½ inches. Pages, 318. London: Sidgwick & Jackson, Ltd. Price, 7s. 6d. net.

This is written from the popular standpoint, and the author has taken a great deal of trouble in securing his information from a variety of sources in all parts of the world. The first few chapters are written from the historical point of view, and trace the evolution of the lifeboat from the earliest days to steam and motor-propelled vessels for life-saving. The British lifeboat system is studied, together with the station and its equipment. This is followed by a chapter upon "the lifeboat at work," in which details associated with some big rescues from wrecks are included.

Details of the life-saving service in various countries cover five chapters. "We are a little apt," says the author, "to look at our own well-nigh perfect system and to plume ourselves upon the superior quality of our humanity. It will be quite a surprise to many to find that the same spirit and the same endeavor are world-wide. It is not too much to say that almost every civilized country that needs a maritime life-saving service has done its best to provide one, and in its human efforts it is pretty certain that it has been well supported by the public, for the lifeboat cause everywhere is a popular one."

An interesting chapter on "Freaks and Oddities" is included, which details some of the extraordinary inventions which have been made in the field of life-saving. Another section deals with the rocket and wreck gun, and a concluding chapter compares and contrasts the services of the world. Nearly 70 reproduced photographs illustrate the work and enhance its interest.

The Western Gate. By Patrick H. W. Ross. Size, 5 by 7½ inches. Pages, 153. New York, 1911: Dodd, Mead & Company. Price, 75 cents net.

In this book some novel ideas are enunciated regarding the restoration of the American merchant marine. The principal idea seems to be to establish a free port in that portion of the State of Washington lying west of the Cascade Mountains, and to build up in that section of the country a shipping and shipbuilding center which would be comparable with Glasgow, Belfast, Stettin, Nagasaki and other foreign shipbuilding centers. The author admits that some provision would have to be made for help by Congress to get the necessary ships, and also that the first requisite for building up the merchant marine is to create in the people throughout the country an ardent desire to own ships. The actual process by which this purpose could be accomplished, however, is left to the reader's imagination.

The Steam Engine and Turbine. By Robert C. H. Heck, M. E. Size, 6 by 9 inches. Pages, 631. Illustrations, 401. New York, 1911: D. Van Nostrand Company. Price, $5 net.

Those familiar with the mechanical engineering department of Rutgers College will need no introduction to the author of this work, nor to a portion of its contents, as part of the volume is adapted from a previous book written by the author, entitled "The Steam Engine and Other Steam Motors." The present book is, first of all, a text-book for engineering students, but it is so complete, as far as the consideration of the steam motor is concerned, that it will prove a most valuable addition to any engineering library. The subjects of the generation and impartation of heat, or, in other words, furnaces and boilers, have not been included, as they are properly considered as subjects which should be treated more fully elsewhere. Between the engine and the turbine more space is devoted to the engine, although, as the author states in the preface, the subject matter in the early chapters is applicable to both, while greater attention is purposely given to the former, on account of the greater value for text-book purposes of the more complete information which is available on this subject.

The Twelve Principles of Efficiency. By Harrington Emerson. Size, 5 by 7½ inches. Pages, 423. New York, 1912: *The Engineering Magazine.* Price, $2.

Harrington Emerson is well known to the engineering world from his work in analyzing the operation of industrial organizations and reducing them to a sound basis of efficiency.

Unfortunately, the majority of manufacturers and managers of industrial organizations have not given as much time and study to the question of efficiency as it deserves. Those who have slighted this part of organization work will be well repaid to examine the twelve principles of efficiency as set forth in this volume by Mr. Emerson. Five of these principles are concerned with the relations between men and the other seven with methods or institutions and systems established in either the manufacturing plant or in the operating and distributing company. These principles will be found fundamental and true, so that they may be used as gages to measure the results in existing organizations. The titles of the chapters are suggestive of the factors entering into the question of efficiency. They are as follows, and each represents a single principle: 1. Ideals. 2. Common Sense and Judgment. 3. Competent Counsel. 4. Discipline. 5. A Fair Deal. 6. Reliable, Immediate and Accurate Records. 7. Planning and Despatching. 8. Standards and Schedules. 9. Standardized Conditions. 10. Standardized Operations. 11. Written Standard Practice Instructions. 12. Efficiency Reward.

The Loss of the Steamship Titanic. By Lawrence Beesley. Size, 5 by 7¼ inches. Pages, 301. Illustrations, 5. Boston and New York, 1912: Houghton & Mifflin Company. Price, $1.20 net.

Even though practically every detail regarding the loss of the *Titanic* has been published and republished in the daily press at the time of the accident, many will appreciate the opportunity to obtain a carefully revised, authoritative statement from a cool-headed witness of the disaster. As this account was not written until the investigation of the disaster had been made in Washington, bringing out practically all of the available information that could be obtained, it can be looked upon as the most correct history of the disaster. The story begins with the construction and preparations for the first voyage of the vessel; the departure from Southampton and an account of the voyage up to the night of the collision; then the collision and embarkation in lifeboats and the sinking of the *Titanic*, as seen from a lifeboat, are fully described from the witness's point of view, which is supplemented by an account of the sinking of the *Titantic*, as seen by one of the survivors from her deck; then follows an account of the rescue and return to New York on board the *Carpathia*. The final chapters discuss the lessons taught by the loss of the *Titanic* and some personal impressions of the disaster. Most of the lessons which Mr. Beesley points out with special emphasis are common knowledge, and are fully realized by every one who has read anything about the disaster. Some of them, however, should be submitted to the probe of competent marine experts before any attempt is made to follow out the suggested remedies.

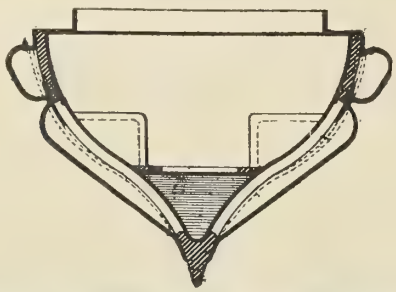
Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,010,309. UNSINKABLE BOAT. JOSEPH PASTOREL, OF ASBURY PARK, NEW JERSEY.

Claim 1.—An unsinkable boat comprising a framework or hull of



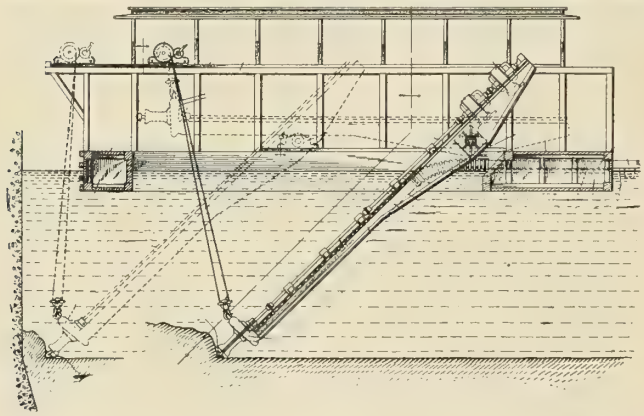
hard rubber, having a number of sheets of air-tight and waterproof material secured thereto on the inside and outside thereof, said sheets forming air compartments which increase the buoyancy of the said boat. Four claims.

1,004,525. GEARING. BENJAMIN BARNES, OF ASTON, SOUTH MELBOURNE, VICTORIA, AUSTRALIA.

Claim 1.—Improved speed-reducing gearing for marine steam turbine engines, comprising a driving shaft provided with a friction boss, three comparatively large equidistant friction wheels adapted to be brought in contact with said boss by means of steam pressure, a driven shaft, and reducing gearing for transmitting the power from said friction wheels to the driven shaft. Four claims.

1,019,610. DREDGING APPARATUS. WILLIAM THOMAS DONNELLY, OF BROOKLYN, N. Y.

Claim 2.—A dredging apparatus comprising a scow having a well leading through its hull, a reciprocable arm fulcrumed thereon and being



adapted to be turned on its fulcrum and lowered through said well into the water to place it into operative position and to be turned on its fulcrum and raised through said hull above the bottom of the scow to place it in transportable position, said arm having on the submergible portion thereof, a centrifugal pump, a pipe leading therefrom and cutting means and on the nonsubmergible portion thereof a source of power, and a rotatable shaft directly connecting the rotable elements of the source of power and the pump and having the said cutting means thereon adjacent the inlet of the pump. Three claims.

1,021,408. BOAT STEERING AND PROPELLING DEVICE. JULIUS E. HASCHKE, OF CHICAGO, ILLINOIS, ASSIGNOR TO JEWEL ELECTRIC CO., OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

Claim 1.—A motor having a housing and a vertical drive shaft, said motor housing providing a jacket-attaching part concentric with said shaft, a propeller structure having a gear and a housing therefor, said gear-housing providing a jacket-attaching part, a vertical shaft at one end engaging said vertical motor shaft and at the other end having a worm engaging said propeller gear, a jacket surrounding said vertical shaft, engaging said jacket-attaching portions of the motor and gear housings, and supporting said motor and propeller; and a clamp for detachable engagement of a boat and for adjustable engagement of said jacket to vary the height of said jacket and jacket-carried motor and propeller relative to the boat. Three claims.

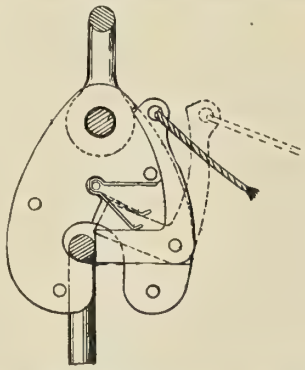
1,021,267. STEERING DEVICE FOR MOTOR-BOATS. NATHANIEL ROE, OF PATCHOGUE, NEW YORK.

Claim 1.—In a steering device, a bracket, a bearing mounted on said bracket and provided with an upwardly projecting shaft, a longitudinally extending shaft journaled in said bearing, a barrel journaled on the first named shaft, and provided with a gearing connection with the second named shaft, a rudder provided with a post, a quadrant carried by said post, and a pinion carried by the barrel and meshing with said quadrant. Three claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

23,323. BOAT-RELEASING HOOKS. J. JORDAN, SYDNEY, N. S.

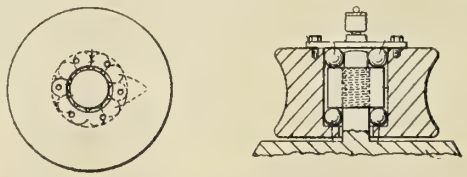
Claim.—The mouth of this hook is closed by one end of a bell crank lever, which acts as a stop and retains the boat ring in position to be



supported by the hook until the other end of the crank is pulled outward, say by means of a line or cord, to raise the stop and so to permit the ring to slide out of the hook.

23,322. BOLLARDS, FAIRLEADS AND THE LIKE. A. OKA, JAPAN.

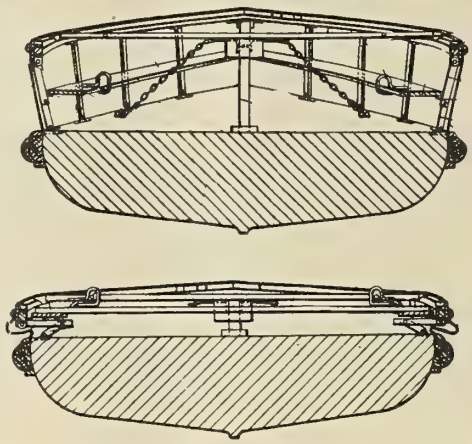
Claim.—By this invention two series of balls are arranged around a fixed pin, and between the latter and the sheave, and abut against a



collar on the pin between the two sets of balls and against the end flanges, or covers, of the sheave. The fixed pin may be integral with the base or in a separate piece and in a modification the collar on it is made readily detachable, for example, by screwing.

12,652. COLLAPSIBLE BOATS. V. ENGELHARDT, COPENHAGEN.

Claim.—Relates to a boat of the kind in which a buoyant lower part carries a top rail on a number of struts which connect the rail with the lower structure in such a way that the rail can be raised or lowered to expand or contract the boat. The present invention provides cross and side seats that are secured in place after the boat is expanded and



which then keep the boat open. The top rail is supported by jointed struts, which fold inwardly and have pins upon which the rigid seat rests. To collapse the boat the seat is raised and supported temporarily on cross-bars by hooks. When the struts fold, the hooks are automatically released and the parts lie compactly together.

12,311. MARINE LIGHTS. T. MANWELL, LONDON.

Claim.—This invention relates to improvements in marine lights of the class in which phosphide of calcium, coming into contact with water, produces flame and smoke. The inner chamber is filled with phosphide of calcium and the outer chamber sealed. When the seal, shown at the top, is broken, and the apparatus comes in contact with water, water enters the outer chamber above, passes into the inner chamber through the slot or perforations on the lower edge of the inner chamber, and comes into contact with the material contained therein. The gas then generated passes out into the outer chamber and up through the water, igniting as it comes into contact with the air.